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ORIGINAL ARTICLES.

ON THE PHYSICAL ASPECTS OF THE MOON'S SURFACE.

By James Nasmyth.

The desire to know something of other worlds besides our own has ever been a prominent one with intelligent minds, and as the telescope has enabled us virtually to reduce the distance between ourselves and those remote orbs that revolve around the sun, many facts have thus been elicited concerning their physical constitution.

Interesting as such facts may be, they are vague and insufficient as compared with those which the telescope has revealed to us, in regard to our nearest celestial neighbour, the Moon, whose comparative proximity enables us, even by the aid of a moderate magnifying power, to gain a very exact knowledge of the physical structure of her surface.

As the Moon's hemisphere, which is ever turned towards us, has its features illuminated in opposite directions during her monthly passage in her orbit around the earth, every part of it is exposed in turn to the rays of the sun, which fall on the details of its features in constantly varying inclinations; and it is from this circumstance that we have such favourable opportunities afforded to us of obtaining a very correct knowledge of the configuration of the details in question, as well as of their height or depression above or below the mean level of the Moon's general surface. Thus it is that we are enabled most carefully to scrutinize her remarkable surface; and should we have drawn any hasty inferences from one set of observations, the opportunity is usually presented to us in the course of a fortnight, or at farthest a month, to correct them if erroneous, or to verify them if accurate, and to pursue further investigations that may be suggested by reflection on what we had last observed.

In these respects telescopic visits to the surface of the moon yield more correct and reliable results than would many a visit to portions of our world where the scenery to be surveyed is not,

perhaps, conveniently accessible; and even when it is reached, the traveller may be surrounded by circumstances which very seriously interfere with his personal comfort, or disturb that tranquillity which is so requisite a condition for close and accurate observation, and thus lead him to hasty conclusions, which he has no future opportunity to rectify. In strong contrast with such circumstances is the position of the astronomer, comfortably placed beside his telescope, in the silence and tranquillity of a fine clear night, with all distracting objects excluded from his view. The whole of his attention is thus brought to focus, as it were, on the point under investigation there and then presented to his scrutiny, and ready to yield perfectly truthful replies to his questions; nothing being requisite for a correct interpretation of facts, other than a quick eye backed by a sound and unbiassed judgment.

It is from circumstances such as these that we have acquired, by a long course of assiduous observation and reflection, an amount of intimate acquaintance with the physical structure of the Moon's exterior, in many important respects far more accurate than is our knowledge of that portion of the earth.

In order rightly to interpret the details of the Moon's surface, as revealed to us by the aid of the telescope, we ought, in the first place, to bear in mind the true nature of volcanic action, namely, that while it has reference to the existence of intense temperature and molten matter, it does not derive its origin from *combustion*, considered as such in a strictly chemical sense, but proceeds from an incandescent condition, induced in matter by the action of that great cosmical law which caused an intense heat to result from the gravitation of particles of matter towards a common centre. These particles, originally existing in a diffused condition, were, by the action of gravitation, made to coalesce, and so to form a planet. Volcanic action, then, has in all probability for its source the heat consequent upon the collapse of such diffused matter, resulting in that molten condition through which there is strong reason to believe all planetary bodies to have passed in their primitive state, and of which condition the geological history of our earth furnishes abundant evidence. Thus the molten lava which we see issuing from an active volcano on the earth, is really and truly a residual portion of that molten matter of which the entire globe once consisted.

In reference to the nature and origin of that eruptive force which had, again and again in the early periods of the Moon's history, caused the remaining molten matter of her interior to be ejected from beneath her solidified crust, and so to assume nearly every variety of volcanic formation in its most characteristic aspect, the key to these may be found in the action of that law which pervades almost all matter in a molten condition, namely, that "molten matter occupies less bulk, weight for weight, than the same material when it has ceased from the molten state;" or, in other words, that "matter in a molten state is specifically more dense than the same material in a solidified condition." Thus it is that in passing from the molten to the solid state the normal law is resumed, and expansion of bulk either just

immediately precedes or accompanies solidification. It is, therefore, in this expansion in the bulk of the solidifying matter, beneath the Moon's crust, that we are to look for the true cause of that eruptive or ejective action which has resulted in the displacement, *surfaceward*, of the fluid portion of the Moon's internal substance; a displacement which has manifested itself in nearly every variety of volcanic formation, such as circular craters with their central cones or mountains of exudation, cracked districts, &c.; all these variations of well-recognized volcanic phenomena being intermingled and overlaid one upon the other in the most striking and wonderful manner. In illustration of this, I would here refer the reader to the lithograph which accompanies this paper, and which has been selected as a fair type of the greater part of the lunar surface where such volcanic features are characteristically displayed.

It may, however, be very reasonably and naturally asked, "What evidence have I that the features I refer to have any relation to volcanic action at all?" In reply to such a question I would direct the inquirer's attention to one single feature which, I conceive, demonstrates more completely than any other the fact of volcanic action having (at however remote a period) existed in full activity in the Moon. The special feature to which I would refer is the central cone that may be observed within those "Ring-formed mountains," as they have been termed. "The central cone" is a well-known and distinctive feature in terrestrial volcanoes. It is the residue of the last expiring efforts of a once energetic eruptive volcanic action, which had thrown the ejected matter to such a considerable distance round about the volcanic vent, that in its descent it had accumulated around in the form of a ring-shaped mountain or crater, whilst on the subsidence of this volcanic energy, the ejected matter was deposited in the immediate vicinity of the vent or volcanic orifice, and thus arose the "central cone."

Anyone who is familiar with terrestrial volcanic craters must, at the first glance at those which are scattered in such infinite numbers over the Moon's surface, detect this well-known analogous feature, the central cone, and at once reasonably infer that these similar forms arose from a common cause, that cause being no other than volcanic action, accompanied by all its most marked characteristics.

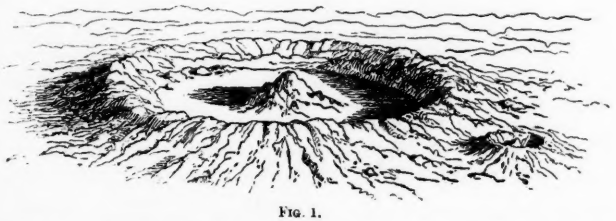


FIG. 1.

Fig. 1. Represents a fair average type of the structure of a Lunar Volcanic Crater with its central cone A.

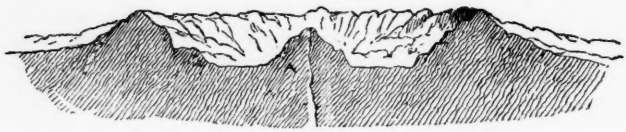


Fig. 2.

Fig. 2. The same in section.

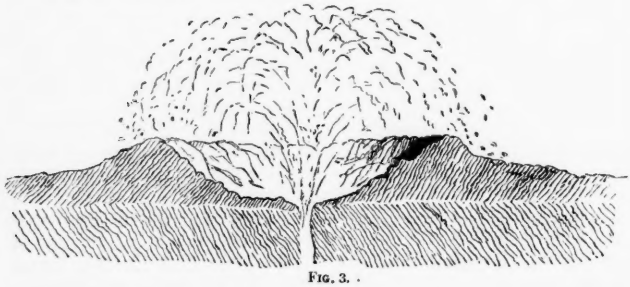


Fig. 3.

Fig. 3. Is the section of a Lunar Crater, showing how by the eruption, and subsequent deposition of the ejected matter, the circular outer wall or crater had been formed.

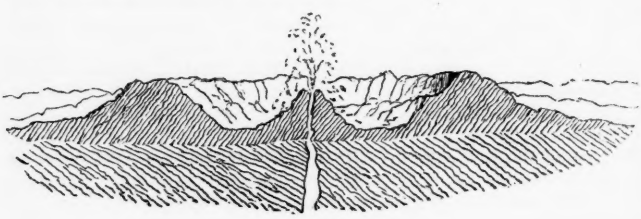


Fig. 4.

Fig. 4. The section of the same, exhibiting the manner in which the central cone had resulted from the expiring efforts of the eruptive action.

In examining the Moon's surface, we cannot but be impressed with the vast dimensions of many of the volcanic craters with which her surface is studded. Craters of thirty miles and upwards in diameter are by no means uncommon, and the first impression on the mind in reference to such magnitudes is one of astonishment, that so small a planet as the Moon (whose magnitude is only about $\frac{1}{49}$th that of the earth) should exhibit evidence of volcanic violence so far greater than any that we have on the earth. This apparent paradox will, however, disappear when we come to consider that in consequence of the Moon being so much less than the earth, the force of gravity on its exterior is not above $\frac{1}{6}$th of that on the earth, and that the weight of

the lunar materials on its surface is reduced in the latter proportion, while, on the other hand, by reason of the small magnitude of the Moon and its proportionately much larger surface in ratio to its magnitude, the rate at which it parted with its original cosmical heat must have been vastly more rapid than in the case of the earth. Now, as the disruptive and eruptive action and energy are in proportion to the greater rate of cooling, those forces must have been much greater in the first instance; and, operating as they did on matter so much reduced in weight as it must be on the surface of the Moon, we thus find in combination two conditions most favourable to the display of volcanic force in the highest degree of violence. Moreover, as the ejected material in its passage from the centre of discharge had not to encounter any atmospheric resistance, it was left to continue the primary impulse of the ejection in the most free and uninterrupted manner, and thus to deposit itself at distances from the volcanic vent so much greater than those of which we have any example in the earth, as to result in the formation of the craters of vast magnitude so frequently encountered in a survey of the Moon's surface. In like manner we find the ejected matter piled up to heights such as create the utmost astonishment; Lunar Mountains of 10,000 feet high are of frequent occurrence, while there are several of much greater altitude, some reaching the vast height of 28,000 feet, and that almost at one bound, as they start up directly from the plane over which they are seen to cast their long black, steeple-like shadows for many a mile; whilst at other times they intercept the rays of the sun upon their highest peaks many hours before their bases emerge from the profound darkness of the long lunar night.

Among the many terribly sublime scenes with which the Moon's surface must abound, none can be grander than that which would present itself to the spectator, were he placed inside of one of these vast volcanic craters (Tycho, for instance), surrounded on every side by the most terrific evidences of volcanic force in its wildest features.

In such a position he would have before him, starting up from the vast plane below, a mighty obelisk-shaped mountain of some 9,000 feet in height, casting its intense black shadow over the plateau; and partly up its slope he would see an amphitheatrical range of mountains beyond, which, in spite of their being about forty miles distant, would appear almost in his immediate proximity (owing to the absence of that "aerial perspective," which in terrestrial scenery imparts a softened aspect to the distant object), so near, indeed, as to reveal every cleft and chasm to the naked eye! This strange commingling of near and distant objects, the inevitable visual consequence of the absence of atmosphere or water, must impart to lunar scenery a terrible aspect; a stern wildness, which may aptly be termed unearthly. And when we seek to picture to ourselves, in addition to the lineaments and conditions of the lunar landscape, the awful effect of an absolutely black firmament, in which every star, visible above the horizon, would shine with a steady brilliancy (all causes of scintillation or twinkling being absent, as these effects are due to the presence of variously heated strata, or currents in our atmosphere), or of the

vivid and glaring sunlight, with which we have nothing to compare in our subdued solar illumination, made more striking by the contrast of an intensely black sky; if, we say, we would picture to ourselves the wild and unearthly scene that would thus be presented to our gaze, we must search for it in the recollection of some fearful dream.

That such a state of things does exist in the Moon we have no reason whatever to doubt, if we may be permitted to judge from inferences reasonably and legitimately deduced from the phenomena on its surface revealed by the telescope; neither can there be a question as to the presence there of the same brilliant tints and hues which accompany volcanic phenomena in terrestrial craters, and which must lend additional effect to the aspect of lunar scenery. Nor must we omit, whilst touching upon the scene that would meet the eye of one placed on the Moon's surface, the wonderful appearance that would be presented by our globe, viewed from the side of the Moon which faces earthward. Possessing sixteen times the superficial area, or four times the diameter, which the Moon exhibits to us, situated high up in the lunar heavens, passing through all the phases of a mighty moon, its external aspect ever changing rapidly as it revolves upon its axis in the brief space of four-and-twenty hours, what a glorious orb it would appear! Whilst its atmospheric phenomena, due to its alternating seasons, and the varying states of weather, would afford a constant source of interest. But, alas! there can be none to witness all these glories, for if ever man was justified in forming a conclusion which possesses the elements of certainty, it is that there can be no organized form of life, animal or vegetable, of which we have any cognizance, that would be able to exist upon the Moon.

Every condition essential to vitality, with which we are conversant, appears to be wanting. No air, no water, but a glaring sun, which pours its fierce burning rays without any modifying influence for fourteen days unceasingly upon the surface, until the resulting temperature may be estimated to have reached fully 212°; and no sooner has that set on any portion of the lunar periphery than a withering cold supervenes; the "cold of space" itself, which must cause the temperature to sink, in all probability, to 250° below zero. What plant, what animal could possibly survive such alternations of heat and cold recurring every fourteen days, or the accompanying climatic conditions?

But let us not suppose, because the Moon is thus unfitted for animal or vegetable existence as known to us, that it is necessarily a useless waste of extinct volcanoes. Apart from its value as "a lamp to the earth," it has a noble task to perform in preventing the stagnation that would otherwise take place in our ocean, which would, without its influence, be one vast stagnant pool, but is now maintained in constant, healthy activity, through the agency of the tides that sweep our shores every four-and-twenty hours, bearing away with them to sea, all that decaying refuse which would otherwise accumulate at the mouths of rivers, there to corrupt, and spread death and pestilence around. This evil, then, the Moon arrests effectively, and

with the tides for a mighty broom, it daily sweeps and purifies our coasts of all that might be dangerous or offensive.

But there is still another duty that she fulfils—namely, in performing the work of a "tug" in bringing vessels up our tidal rivers. Dwellers in seaports, or those who reside in towns situated up our tidal streams, have excellent opportunities of observing and appreciating her value in her towing capacity; and, indeed, it may with truth be said that no small portion of the corn with which we are nourished, and of the coal that glows in our firesides, is brought almost up to our very doors by the direct agency of the Moon.

GUN-COTTON.

By JOHN SCOTT RUSSELL, C.E., F.R.S.

THE elements are proverbially good servants, but bad masters—Fire, water, wind, and steam are fierce demons when they get the upper hand; yet what would civilization be, wanting the fire of the kitchen, the smith's hearth, and the foundry; how should we be, without seas to carry our boats or rivers to turn our mills? Commerce and merchandise are mainly conducted by the wind and the sails of our merchantmen; and steam clothes us, and carries us from city to farm, and from island to continent; yet the earthquake, the volcano, the conflagration, the torrent, the storm, the hurricane, and the explosion —what are they but servants become masters?

It is peculiarly true of steam and gunpowder that they are among the most useful, and most dangerous of human inventions; but danger in both is generally admitted to be a matter merely of skill and care. No one proposes to put down railways because a locomotive explodes, or to give up shooting because a gun has burst, or a gunpowder manufactory blown up.

Gun-cotton is a new power coming under the same category as steam and gunpowder. It is highly dangerous to those who don't possess the necessary knowledge and skill; but, like them, it enormously extends human power, and, like them, the skill to use it can be rightly and certainly acquired.

The object of this paper is to extend the knowledge and skill of my countrymen in the use of this new power. It is, I believe, of far more value to England than to any other nation in the world. It is, in my opinion, a power capable of being extensively used for a multitude of purposes yet unheard of: and I believe it will play an important part in the destinies of England.

The first question we naturally ask on the introduction of a new power is, what are to be its advantages over existing powers and processes? In regard to gun-cotton, we at once ask, therefore, what are its advantages over gunpowder? Is it stronger? Is it more convenient? Is it cheaper? Why should we give up gunpowder and

take to gun-cotton? The answers to these questions categorically will best introduce it to the English reader.

I. Is gun-cotton stronger than gunpowder? The answer to this is, Yes, sixfold stronger.

By this we mean that if we take a given weight of gun-cotton, say four ounces, if we bore a hole 1½ inch in diameter and 3 feet deep, into hard rock or slate, in a quarry, and put 4 ounces of gun-cotton into it, it will occupy about 1 foot of its length, and the aperture being closed in the usual manner, and a matchline led from the charge to the proper distance from which to fire it; and if we next take 24 ounces of best gunpowder, bore a similar hole, and charge it similarly with gunpowder, and close it in the same way; it has been found that, on these being exploded, the 4 ounces of gun-cotton have produced greater effect, in separating the rock into pieces, than the 24 ounces of gunpowder. The answer is, therefore, that in disruptive explosion the strength of gun-cotton is sixfold that of good gunpowder.

But the disruptive or bursting power of gunpowder is not always the quality for which we value it most, nor the service we require of it. In mining rocks, in exploding shells, in blowing up fortresses, this property is what we value, and this work is what we require. But we do not want to burst our fowling-pieces, our rifles, our cannon. On the contrary, we want to use a force that shall project the projectile out of the gun without bursting the gun, without straining the gun beyond a given moderate limit, which it shall be able to endure. We want therefore a service from gun-cotton which shall be the contrary of destructive to, or disruptive of, the chamber in which it does the work of giving motion to the projectile.

This moderated and modified work, gun-cotton can also perform; and it is the modern discovery of General Lenk, which has enabled us to moderate and modify gun-cotton to this gentler service. He discovered how to organize, arrange, and dispose mechanically of gun-cotton in such a way that it should be three times stronger than gunpowder. Accordingly, one of his charges of gun-cotton, weighing 16 ounces, projected a 12-pound solid round shot with a speed of 1,426 feet a second, while a charge of gunpowder of 49 ounces gave the same shot a speed of 1,400 feet a second. One-third of the weight of gun-cotton exceeded, therefore, the threefold weight of gunpowder in useful effect.

II. Is gun-cotton more convenient than gunpowder? This is a larger and more various question than the former, and divides itself into various subdivisions.

It is well known to sportsmen, to soldiers, to artillery-men, that gunpowder fouls a gun. A foul residue of soot, sulphur, and potash soils the inside of the gun after every charge. The gun must, somehow, be cleaned after a discharge; if not it fires worse, recoils more, and ceases to do its best. If the gun be a breech-loading gun its mechanism is dirtied, and works less easily. Gun-cotton deposits no residue, leaves the gun clean and clear, and the utmost it does is to leave a gentle dew of clear water on the inside of the bore, this water

being the condensed steam which forms one of the products of its decomposition. Gun-cotton is, therefore, superior to gunpowder in not fouling the gun, a result favourable both to quicker and more accurate firing.

It is further a matter of no slight convenience that gun-cotton makes no smoke. In mines the smoke of gunpowder makes the air unbreathable, and for some time after explosion the miners cannot return to their work. In boring the great tunnel of Mont Cenis through the Alps, the delay from smoke of powder alone will postpone the opening of the line for many months. After a properly-conducted explosion of gun-cotton, the workmen may proceed in their work at once without inconvenience.

In casemates of fortresses, gunpowder fills the casemates with foul smoke, and the men speedily sink under the exertion of quick firing. By using gun-cotton it was ascertained that the men could continue their work unharmed for double the quantity of firing. This is partly attributed to the greater heat, and partly to the foulness of the air produced by gunpowder.

But it is under the decks of our men-of-war, that greatest benefit is likely to arise from gun-cotton. Not only does the smoke of a broadside fill the between decks with hot and foul air, but the smoke of the windward gun blinds the sight, and hinders the aim of the lee-ward. When there is no smoke, as with gun-cotton, the aim of every gun may be precise and deliberate. The diminished heat between decks will also tell powerfully in favour of gun-cotton. In our armour-plated ships also there is more value in breech-loading guns, than in any other use of artillery. It is one of the necessities of breech-loading mechanism, that it be kept clean, and nothing tends more to derange its perfect action than the greater heat which gun-powder imparts to the gun from which it is fired.

That gun-cotton has the convenience of not heating the gun has been thus proved. 100 rounds were fired in 34 minutes with gun-cotton, and the temperature of the gun was raised 90°. 100 rounds were fired with gunpowder, and triple the time allowed to cool the gun, which nevertheless was heated so much as to evaporate water with a hissing sound, which indicated that its temperature was much above 212°. Under these circumstances the firing with gunpowder had to be stopped, while that with gun-cotton was comfortably continued to 180 rounds.

It is also a matter of practical convenience that gun-cotton, inso-much as it is lighter, can be carried more easily and farther than gun-powder; and it may be wetted without danger, so that when dried again in the open air, it is as good for use as before.

III. We have now to ask—is it cheaper? The answer to this question must be qualified—pound for pound it is dearer; we must therefore judge of its cheapness by its effect, not by weight merely. But where it does six times as much work, it can then be used at six times the price per pound and still be as cheap as gunpowder. As far as we yet know, the prices of gun-cotton and gunpowder are nearly equal, and it is only therefore where the one has advantages and con-

veniences beyond the other, and is more especially suited for some specific purpose, that it will have the preference. Effective cheapness will therefore depend mainly on which of the two does best the particular kind of duty required of it.

To illustrate how curiously these two powers, gun-cotton and gunpowder, differ in their nature, and how the action of gun-cotton may be changed by mechanical arrangements, we may take one kind of work that is required of both :—If a General want to blow open the gates of a city, he orders an enterprising party to steal up to the gate, with a bag containing 100 lbs. of gunpowder, which he nails to the gate, and by a proper match-line he fires the gunpowder and bursts open the gate. If he nailed a bag of gun-cotton of equal weight in the same place and fired it, the gun-cotton would fail, and the gate would be uninjured, although the 100 lbs. of gun-cotton is sixfold more powerful than the gunpowder. Here, then, gunpowder has the advantage—both weight and effect considered.

But the fault here lies not in the gun-cotton, but the way of using it. If instead of 100 lbs. of gun-cotton in a bag, 25 lbs. had been taken in a proper box made for this purpose, and simply laid down near the gate, and not even nailed to it, this 25 lbs. would shiver the gate into splinters. The bag which suits the powder happens not to suit the gun-cotton.

Gun-cotton is therefore a power of a totally different nature from gunpowder, and requires complete study to know its nature and understand its use. It appears that both gunpowder and gun-cotton have special qualities, and may be peculiarly suited for peculiar uses. It is the duty of a wise people to make use of both to the ends they each suit best, without prejudice arising from the accident of novelty or antiquity.

The nature of gun-cotton requires a double study, chemical and mechanical. It is not like steam, the same substance, whether in the form of ice or water or steam. It is one substance when as gun-cotton it enters the gun, and quite a different one when it has exploded and leaves the gun. Not only are the solids which enter converted into gas, but they form totally new combinations and substances. So that the marvellous changes which the chemist effects by the magic of his art take place in an instant of time, and during that almost inconceivably minute period of time, in a laboratory intensely heated, old substances are dissolved, their material atoms are redistributed, each atom released selects by natural affinity a new partner, these new unions are cemented, and at the end of this prolific instant totally new combinations of matter, forming what we call new substances, issue from the gun. It so happens that of these new substances, formed out of gun-cotton, all are pure transparent gases, while in the case of gunpowder there remain 68 per cent. of solid residue, and only 32 per cent. are pure gases.

It is to chemistry however, that we must look for full and authentic information as to these wonderful changes : first, from the innocent, gentle cotton wool in which our wives and daughters wrap their jewels for soft keeping, into the terrible and irresistible compound of nitric

acid and cotton fibre which forms tri-nitro-cellulose, the chemical name of gun-cotton. Chemistry must also tell us how tri-nitro-cellulose is to be turned by heat into transparent explosive gases of such tremendous power.

In short, chemistry has to supply us with the new material, and it is to the science of mechanics that we must look for inventions, of the best way to manipulate and apply it to use for doing the practical work we set it to, in the most effectual, convenient, and economical way.

The chemistry of gun-cotton is therefore the first part of our study of this power, and the mechanics of gun-cotton forms the second.

I.—THE CHEMISTRY OF GUN-COTTON.*

Although gun-cotton was discovered eighteen years ago by one of the first chemists of the day, Professor Schönbein, and researches on its nature and preparation were almost immediately instituted in this country by Porrett, Teschemacher, Taylor, Gladstone and others, no accurate knowledge of the true constitution and chemical nature of this important material was obtained until Hadow, an English chemist, published in 1854 the result of some valuable investigations by which the mode of formation and composition of gun-cotton were conclusively established.

Cotton, or cellulose as it is termed by chemists, is built up of a certain number of atoms of carbon, oxygen, and hydrogen. Chemistry is scarcely yet able to point out how these atoms are probably arranged; but there appears to be no doubt that some of the elementary particles are so intimately connected with the very existence of cotton, that they cannot be displaced or removed without destroying the very existence of the substance; whilst other atoms, on the contrary, are more loosely held together, and are gifted with a certain mobility which enables them to be taken out altogether without materially altering the outward physical character of the cotton, provided the spaces which these atoms would leave vacant, are immediately filled up by certain other atoms. Now, without entering into the details of chemical formulæ, which would neither interest our readers nor render our meaning more intelligible, we may briefly say that, in ordinary cotton, three atoms of the hydrogen (of which there are ten altogether) are in this loose state of combination, and may be removed and their places filled up by a compound atom of *hyponitric acid* without so far altering the character of the substance as to render the name of cotton inapplicable to it. It may be just mentioned in passing, that it is not necessary that the whole three atoms of hydrogen should be taken out and their places filled up by hyponitric acid; only one or two of them may be so replaced, but as these are inferior for explosive purposes (although of great use to photographers, inasmuch as when dissolved in ether they form collodion), we need

* For this portion of my paper I am indebted to the kindness of Mr. Wm. Crookes, F.R.S.

only direct our attention to the compound with the highest displacement. From its explosiveness and consequent similarity to gun-*powder*, this has been called gun-*cotton*. In scientific language, following the excellent custom adopted by chemists in the nomenclature of organic compounds, a name has been given to it which fully expresses its composition: *cellulose* being the scientific name for cotton, and the prefix *nitro* being added when any of the hydrogen in an organic compound is replaced by hyponitric acid (by no means an uncommon occurrence in organic chemistry), chemists call the product in this instance *tri-nitro-cellulose*, signifying that it is cellulose, in which three equivalents of the hydrogen are replaced by nitrous acid. It is also sometimes called *pyroxilin*, under the impression, we suppose, that by translating a useful English term into barbarous Greek it becomes scientific. This system of pseudo-scientific nomenclature is, unfortunately, too common. If an expressive, convenient, but empirical name be desired, by all means let us have the common English name in popular use. If, on the other hand, a scientific term be required, let us, in the name of all that is scientific, build up this name according to the orthodox rules of science; but we protest against a name like pyroxilin, which leads to nothing but the inference that science is not indigenous to the soil of England.

Most European governments have attempted to utilize gun-cotton in warfare. Soon after its discovery, Messrs. Hall, the well-known gunpowder makers at Faversham, commenced its manufacture upon a considerable scale: their factory had, however, not been long in operation before a very disastrous explosion occurred, by which a number of men lost their lives, and this was ascribed to the spontaneous ignition of the gun-cotton: the manufacture was therefore abandoned in England.

As early as the winter of 1846 a French manufactory was established at the Government Powder Works at Bouchet, near Paris, and much valuable information was obtained respecting the comparative value of gun-cotton and gunpowder; but three disastrous explosions occurring within a year (one taking place in a magazine near which it was believed that no one had been for several days) put a stop, until quite recently, to further experiments.

In Austria, experiments were likewise instituted, and although the committee of the German Confederation pronounced unfavourably upon it, one of the members, General Lenk, devoted himself assiduously to its study, and with such success that the Austrian Government were induced to reconsider their adverse determination. The manufacture was commenced upon a large scale, and above forty batteries of guns were furnished with this agent, and successfully used. The complete supersession of gunpowder by gun-cotton was considered certain, when an explosion, which took place at the Austrian gun-cotton magazines at Limering, again put a stop (to some extent) to its use in artillery. Another Austrian committee, however, reported so favourably on its value, stability, and non-liability to spontaneous explosion, that gun-cotton was again restored to favour.

The very favourable accounts respecting the value of gun-cotton

for warlike purposes, which were from time to time received by our government, led to experiments on a considerable scale in this country. The manufacture of this agent is now in full operation both at the Government Powder Works at Waltham Abbey, and also at a large private manufactory at Stowmarket.

The great danger in the case of the early gun-cotton was its liability to spontaneous explosion, and whilst there remained the slightest suspicion of such a possibility, its employment for war purposes was out of the question. The investigations of General Lenk have shown that this accident is due to imperfect preparation, and that by adopting the precautions which he has pointed out, its spontaneous ignition is impossible. It has been very clearly established that the lower nitro-compounds of cellulose, that is, cotton in which only one or two of the atoms of hydrogen are replaced by hyponitric acid, are much more easily decomposed than the compound in which the replacement has proceeded to its fullest extent. Tri-nitro-cellulose, or true gun-cotton, is a remarkably stable compound under all possible atmospheric conditions, but it is by no means easy to ensure the complete conversion of cotton into this body, and it has been shown to be in the highest degree probable that the explosions which put a stop to the early attempts at utilizing gun-cotton were due to its incomplete conversion. The directions given by Schönbein, although successful on the small scale, fail when tried with large quantities, and to General Lenk is due the credit of devising a process of manufacture which gives an absolutely uniform and true chemical compound when working on the largest scale. Ordinary gun-cotton is generally made by saturating cotton-wool with a mixture of one part of concentrated nitric acid and three parts of oil of vitriol, and allowing the mixture to stand at rest for one hour; it is then thoroughly washed and allowed to dry in the air. This process is tolerably successful when only about half-an-ounce of cotton is treated at one time, but it is found to be ineffectual in making a uniform and safe material for war purposes. The most important of the precautions recommended by General Lenk, are, the cleansing and perfect desiccation of the cotton as a preliminary to its immersion in the acids; the employment of the strongest acids obtainable in commerce; the steeping of the cotton in a strong mixture of acids after its first immersion and its partial conversion into gun-cotton; the continuance of the steeping for forty-eight hours; and the thorough purification of the gun-cotton so produced from every trace of free acid: this is secured by its being washed in a stream of water for several weeks. Subsequently a weak solution of potash may be used, but this is not essential. The prolonged continuance of these processes, which would appear superfluous at first sight, is really essential, when we consider that each cotton fibre is a long, narrow, tube, often twisted and even doubled up, and the acid has first to penetrate into the very farthest depths of these tubes, and has afterwards to be soaked out of them. Hence the necessity of time.

It appears that gun-cotton, prepared in this manner, is a true chemical compound, and is not liable to the objections which have been urged against that mixture of compounds which has been usually

employed in experiments. The advantages which it possesses may be classed as follows:—

1. It is of uniform composition, and thus the force of the gases generated on explosion may be accurately estimated.

2. It will not ignite till raised to a temperature of 300° F. (as a rule, the temperature must be raised much higher). This is considerably lower than the igniting point of gunpowder, but, being much above the heat of boiling water, it can only occur when artificially produced by means which would render gunpowder itself liable to ignition.

3. It is almost absolutely free from ash when exploded under pressure in a confined space.

4. It has a very marked superiority in stability over other forms of gun-cotton, having been kept unaltered for fifteen years.

One great advantage which gun-cotton possesses over gunpowder, and which ought to have considerable weight in any discussion of their comparative uses for national purposes, is, that gun-cotton is unaffected by water. Gunpowder in a damp atmosphere will soon be completely spoiled, and it cannot afterwards be restored to a serviceable condition without being again submitted to the processes of manufacture, starting almost from the commencement. Gun-cotton, on the contrary, although it gets damp in a moist atmosphere, rapidly returns to its ordinary state when exposed to air of average dryness. Complete immersion in water for an indefinite period has no injurious action on it, for when afterwards dried by exposure to the air, it is as good as ever. The absolute safety which this property would confer upon the magazines of forts and ships cannot be too highly urged; the explosive material could be kept permanently in tanks full of water, in which case a lighted candle or even a red-hot shot would be a harmless visitant. When required for action, a centrifugal drying machine and a hot-water closet would supply the combatants with any quantity at a few hours' notice.

When gun-cotton is ignited in a close vessel, such as a shell or the chamber of a gun, it is at once converted into certain gases, the principal being carbonic oxide, carbonic acid, nitrogen, light carburetted hydrogen, hydrogen, and steam. The introduction of the hyponitric acid, a compound containing a large excess of oxygen, gives to the cotton a sufficient amount of this gas to reduce it completely to the state of vapour; but although only gases are produced, there is not enough oxygen for their complete combustion. About 40 per cent. are inflammable, and produce a bright flash when they emerge into the air from the mouth of the gun.

II.—The Mechanics of Gun-cotton.

The mechanical application of gun-cotton may be considered to be due exclusively to Major-General Lenk, of the Austrian service. Pure gun-cotton becomes either a powerful explosive agent, or a docile performer of mechanical duty, not according to any change in its composition, or variation in its elements or their proportions, but according

to the mechanical structure which is given to it, or the mechanical arrangements of which it is made a part. It was General Lenk who discovered that structure was quality, and mechanical arrangement the measure of power, in gun-cotton; and in his hands, a given quantity of the same cotton becomes a mild, harmless, ineffectual firework, a terrible, irresistible, explosive agent, or a pliable, powerful, obedient workman.

The first form which General Lenk bestowed on gun-cotton was that of a continuous yarn or spun thread. Gunpowder is carefully made into round grains of a specific size. Gun-cotton is simply a long thread of cotton fibre, systematically spun into a yarn of given weight per yard, of given tension, of given specific weight. A hank of a given length is reeled, just like a hank of cotton yarn to be made into cloth, and in this state gun-cotton yarn is bought and sold like any other article of commerce.

This cotton yarn converted into gun-cotton may be called, therefore, the raw material of commerce. In this form it is not at all explosive in the common sense of the word. You may set fire to a hank of it, and it will burn rapidly with a large flame; but if you yourself keep out of the reach of the flame, and keep other combustibles beyond reach, no harm will happen, and no explosion or concussion will result. If you lay a long thread of it round your garden walk at night, disposing it in a waving line with large balls of gun-cotton thread at intervals, and light one end of the thread, it will form a beautiful firework, the slow lambent flame creeping along with a will-o'-th'-wisp-looking light, only with a measured speed of 6 inches per second, or 30 feet a minute; the wind hastening it or retarding it as it blows with or against the line of the thread. This is the best way to commence an acquaintance with this interesting agent.

Care must be taken not to become too familiar with gun-cotton even in this harmless and playful guise; cotton dresses will readily catch fire from it, and it should not be treated with less care to keep fire from it than gunpowder. In one respect it is less liable to cause danger than gunpowder. Grains of powder are easily dropped through a crevice, and may be sprinkled about in a scarcely noticeable form, but a hank of gun-cotton is a unit, which hangs together and cannot strew itself about by accident.

The *second* form of gun-cotton is an arrangement compounded out of the elementary yarn. It resembles the plaited cover of a riding-whip; it is plaited round a core or centre which is hollow. In this form it is match-line, and, although formed merely of the yarn plaited into a round hollow cord, this mechanical arrangement has at once conferred on it the quality of speed. Instead of travelling as before only 6 inches a second, it now travels 6 feet a second.

The *third* step in mechanical arrangement is to enclose this cord in a close outer skin or coating, made generally of India-rubber cloth, and in this shape it forms a kind of match-line, that will carry fire at a speed of from 20 to 30 feet per second.

It is not easy to gather from these changes what is the cause which so completely changes the nature of the raw cotton by mechanical

arrangement alone. Why a straight cotton thread should burn with a slow creeping motion when laid out straight, and with a rapid one when wound round in a cord, and again much faster when closed in from the air, is far from obvious at first sight; but the facts being so, deserve mature consideration.

The cartridge of a common rifle in gun-cotton is nothing more than a piece of match-line in the second form enclosed in a stout paper-tube, to prevent it being rammed down like powder. The ramming down, which is essential to the effective action of gunpowder, is fatal to that of gun-cotton. To get useful work out of a gun-cotton rifle, the shot must on no account be rammed down, but simply transferred to its place. Air left in a gunpowder barrel is often supposed to burst the gun; in a gun-cotton barrel, it only mitigates the effect of the charge. The object of enclosing the gun-cotton charge in a hard strong pasteboard cartridge, is to keep the cotton from compression and give it room to do its work.

It is a *fourth* discovery of General Lenk, that to enable gun-cotton to perform its work in artillery practice, the one thing to be done is to "give it room." Don't press it together—don't cram it into small bulk! give it at least as much room as gunpowder in the gun, even though there be only one-third or one-fourth of the quantity (measured by weight). 1 lb. of gun-cotton will carry a shot as far as 3 or 4 lbs. of gunpowder; but that pound should have at least a space of 160 cubic inches in which to work.

This law rules the practical application of gun-cotton to artillery. A cartridge must not be compact, it must be spread out or expanded to the full room it requires. For this purpose, a hollow space is preserved in the centre of the cartridge by some means or other. The best means is to use a hollow thin wooden tube to form a core; this tube should be as long as to leave a sufficient space behind the shot for the gun-cotton. On this long core the simple cotton yarn is wound round like thread on a bobbin, and sufficiently thick to fill the chamber of the gun; indeed, a lady's bobbin of cotton thread is the innocent type of the most destructive power of modern times—only the wood in the bobbin must be small in quantity in proportion to the gun-cotton in the charge. There is no other precaution requisite except to enclose the whole in the usual flannel bag.

The artillerist who uses gun-cotton has therefore a tolerably simple task to perform if he merely wants gun-cotton to do the duty of gunpowder. He has only to occupy the same space as the gunpowder with one-fourth of the weight of gun-cotton made up in the bobbin as described, and he will fire the same shot at the same speed. This is speaking in a general way, for it may require in some guns as much as $\frac{1}{3}$ of the weight of gunpowder and $\frac{1}{10}$ the bulk of charge to do the same work; a little experience will settle the exact point, and greater experience may enable the gun-cotton to exceed the performance of the gunpowder in every way.

The *fifth principle* in the use of gun-cotton is that involved in its application to bursting uses. The miner wants the stratum of coal torn from its bed, or the fragment of ore riven from its lair; the civil

engineer wishes to remove a mountain of stone out of the way of a locomotive engine; and the military engineer to drive his way into the fortress of an enemy, or to destroy the obstacles purposely laid in his way. This is a new phase of duty for gun-cotton—it is the work of direct destruction. In artillery you do not want to destroy directly, but indirectly. You don't want to burst your gun, nor even to injure it; and, we have seen, in order to secure this, you have only to give it room.

The fifth principle, therefore, is, to make it destructive—to cause it to shatter everything to pieces which it touches, and for this purpose you have only to deprive it of room. Give it room, and it is obedient; imprison it, and it rebels. Shut up without room, there is nothing tough enough or strong enough to stand against it.

To carry this into effect, the densest kind of gun-cotton must be used. It must no longer consist of fine threads or hollow textures wound on roomy cores. All you have to do is to make it dense, solid, hard. Twist it, squeeze it, ram it, compress it; and insert this hard, dense cotton rope or cylinder or cake in a hole in a rock, or the drift of a tunnel, or the bore of a mine; close it up, and it will shatter it to pieces. In a recent experiment, 6 ounces of this material set to work in a tunnel not only brought down masses which powder had failed to work, but shook the ground under the feet of the engineers in a way never done by the heaviest charges of powder.

To make gun-cotton formidable and destructive, squeeze it and close it up; to make it gentle, slow, and manageable, ease it and give it room. To make gunpowder slow and gentle, you do just the contrary: you cake, condense, and harden it to make it slow, safe for guns, and effective.

To carry out this principle successfully, you have to carry it even to the extreme. Ask gun-cotton to separate a rock already half-separated, it will refuse to comply with your request. Give it a light burden of earth and open rock to lift, it will fail. If you want it to do the work, you must invent a ruse,—you must make believe that the work is hard, and it will be done. Invent a difficulty and put it between the cotton and its too easy work, and it will do it. The device is amazingly successful. If the cotton have work to do that is light and easy, you provide it with a strong box, which is hard to burst, a box of iron for example; close a small charge, that would be harmless, in a little iron box, and then place that box in the hole where formerly the charge exploded harmless, and in the effort it makes to burst that box, the whole of the light work will disappear before it.

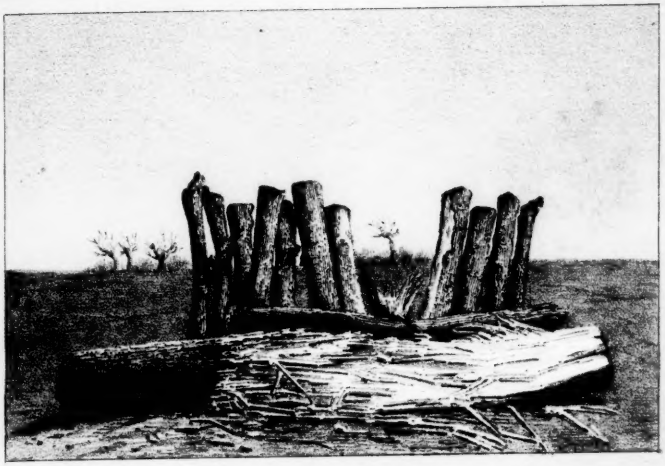
Of the effect of such an explosion, an illustration accompanies this paper. The two drawings represent two views of a stockade, in close contiguity to which a charge of 25 lbs. of gun-cotton, placed in an iron box, was employed, and the consequences will be seen in the two rent and shattered trees, the largest 20 inches in diameter, which were not only removed from their places, but by some unexplained action shattered throughout into matchwood. This explosion was the

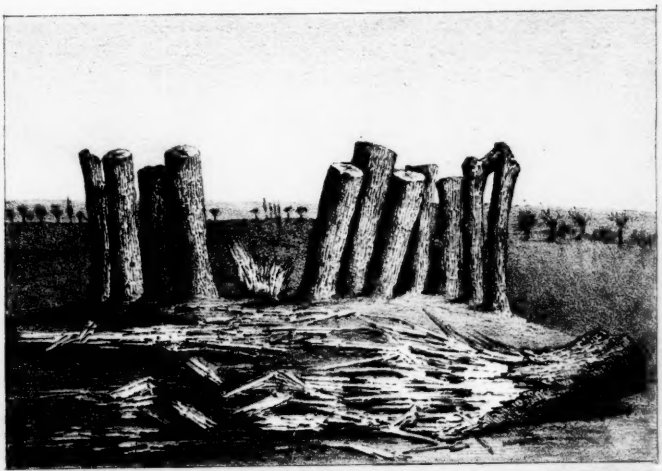
first trial of English-made gun-cotton, and was made at Stowmarket, in spring.

It is, therefore, the nature of gun-cotton to rise to the occasion and to exert force exactly in proportion to the obstacle it encounters. For destructive shells this quality is of the highest value. You can make your shell so strong that nothing can resist its entrance, and when arrived at its destination no shell can prevent its gun-cotton charge from shivering it to fragments.

These are the main principles in the mechanical manipulation of gun-cotton which will probably render it for the future so formidable an instrument of war. Resistances too great for gunpowder only suffice to elicit the powers of gun-cotton. On the other hand, in its elementary state as the open cotton yarn, it is playful, slow, gentle, and obedient; there is scarcely any mechanical drudgery you can require of it that it is not as ready and fit to do as steam, or gas, or water, or other elementary power.

In conclusion, I may be asked to say as a mechanic what I think can be the nature and source of this amazing power of gun-cotton. In reply let me ask, Who shall say what takes place in that pregnant instant of time when a spark of fire enters the charge, and one-hundredth part of a second of time suffices to set millions of material atoms loose from fast ties of former affinity, and leaves them free every one to elect his mate, and uniting in a new bond of affinity, to come out of that chamber a series of new-born substances? Who shall tell me all that happens then? I will not dare to describe the phenomena of that pregnant instant. But I will say this, that it is an instant of intense heat—one of its new-born children is a large volume of steam and water. When that intense heat and that red-hot steam were united in the chamber of that gun and that mine, two powers were met whose union no matter yet contrived has been strong enough to compress and confine. When I say that a gun-cotton gun is a steam-gun, and when I say that at that instant of intense heat, the atoms of water and the atoms of fire are in contact atom to atom, it is hard to believe that it should not give rise to an explosion infinitely stronger than any case of the generation of steam by filtering the heat leisurely through the metal skins of any high-pressure boiler.





from Photographs. M & N Hanhart Imp De Wilde lith.

EXPLOSIVE EFFECTS OF THE FIRST CHARGE OF ENGLISH MADE GUN COTTON
(Two views of the Stockade)

BRACKISH-WATER FOSSILS OF CRETE.

Being Illustrations of the Characters of Fluviatile, Lacustrine, and Estuarine Formations.

By H. M. JENKINS, F.G.S., Assistant-Secretary of the Geological Society.

THE Grecian Archipelago and the surrounding mainland have a truly classic interest for the Geologist, not so much on account of their geographical position and ancient fame, as because they were the scenes of some of the most famous labours of the late Professor Edward Forbes, a naturalist who, in his brief but brilliant career, was enabled, chiefly through his investigations in these regions, to throw the bright light of genius over some of the most intricate paths of palæontological research, and who thus invested the eastern portion of the Mediterranean with a far greater interest to the geologist than it otherwise ever would have possessed. Still it must not be supposed that the region is barren of facts outside the common course of geological phenomena, for, as was shown by Professor Forbes, the fresh-water and estuarine strata which occur there contain fossils exhibiting remarkable modifications of form caused by the more or less adverse influences of the conditions under which they lived.

The fossil shells which have given rise to this paper, and which are figured in the Plate, and described in the Appendix, were submitted to my examination by Capt. T. Spratt, R.N., C.B., F.G.S., who was the companion of Professor Edward Forbes in a great portion of his travels in Asia Minor and the regions round about, and conjoint-author with him of the 'Travels in Lycia;' and he is now busily engaged in bringing out a work on the Island of Crete, which will doubtless add to his already high reputation as a geologist.

Of the other observers who have travelled in these regions, and have contributed to our knowledge of their geology, I may mention Mr. Hamilton, F.R.S., now President of the Geological Society, and his fellow-traveller, the late Hugh Strickland, who were the first to explore geologically these classic countries. We are also much indebted to M. Tchihatcheff and M. Raulin, whose papers have been published in the 'Bulletin de la Société Géologique de France.'

The ancient Lake of the Eastern Mediterranean.—One of the principal points brought forward by Captain Spratt, in his several papers, is that the Eastern portion of the Mediterranean, including Greece, parts of Asia Minor, and probably the north-eastern extremity of Africa, was at some distant epoch in the Tertiary period, the site of a huge fresh-water lake; but the precise geological date at which it existed has not yet been satisfactorily made out, though it probably coincided with that of the deposition of the estuarine strata about to be noticed.

Many years ago, Messrs. Hamilton and Strickland described a series of lacustrine beds in various parts of Asia Minor, where it appears

to be the formation most commonly met with in the low grounds; while Captain Spratt has given descriptions of similar strata occurring near Smyrna, and in Lycia, as well as in the Islands of Samos, Rhodes, Cos, Cerigo, &c.; but there is some confusion as to their probable age. Captain Spratt originally considered all of them to be of Eocene date, it being borne in mind, however, that when that opinion was published, the term 'Eocene' included what is now known as Lower Miocene, and referred to under that name in these pages. With the assistance of Professor Forbes, this opinion was afterwards somewhat modified, the Smyrna beds being still retained as Eocene (=Lower Miocene), but the Lycian strata, as well as those of Cos and Rhodes, being considered newer. To the supposed age of these newer fresh-water beds I shall have occasion to refer presently at some length, as it bears very importantly upon the age of some of the fossils under consideration.

Geology of the Eastern Mediterranean Region.—The Tertiary beds of Greece, of the Islands of the Archipelago, and of Asia Minor, are generally found reposing on the Apennine Limestone, or Scaglia, which is of Cretaceous age, or else abutting against it, the Scaglia in such cases forming the high land of the interior, and the Tertiary beds skirting it and facing the sea, and often extending to the coast. Some of these Tertiary strata contain marine remains, others include fresh-water (probably lacustrine) organisms, and the fossils figured in the Plate were probably from a brackish-water lake or estuary.

For the better understanding of the subject it will, first of all, be necessary to give a synopsis of the argument which has been supposed to prove that the fresh-water beds of the Valley of the Xanthus, of Cos, and of Rhodes, are of Pliocene age, and for this purpose I must call in the aid of Professor Forbes and Captain Spratt.*

Relative Age of the Marine and Fresh-water Strata of Lycia.—In the Valleys of Xanthus and Kassabar there is a fresh-water formation supposed to be more recent than certain marine sandy strata, containing shells which also occur in the Upper Miocene beds of Bordeaux, Touraine, &c.; and the manner in which this is apparently proved may be thus stated. The valley of Xanthus is bounded on each side by hills of highly-inclined Scaglia, upon which rests conformably a slightly newer deposit termed 'Macigno.' The floor of the valley consists of horizontal beds of marl, capped by conglomerate, and containing fresh-water fossils. High up on the hill-sides are patches of the marine formation in question, dipping west at a high angle, and it has been assumed to be the older, entirely on account of its being inclined, while the fresh-water beds are horizontal; the order of events being—(1) its deposition horizontally over where the valley now is, (2) its tilting-up and entire denudation, and (3) the deposition of fresh-water beds in its place. Granting the assumed basis of the argument, the reasoning is perfectly correct.

Furthermore, the Xanthus fossils are some of them identical with those occurring in the island of Cos, in a fresh-water formation forming

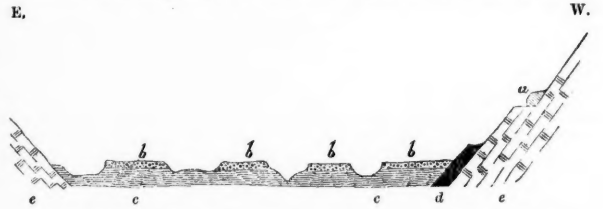
* 'Travels in Lycia,' vol. ii. p. 175.

the wall of a series of marine beds containing newer Pliocene fossils; so that the fresh-water beds must be the older, and as, granting the correctness of the former argument, they have been proved to be newer than the Upper Miocene, they must, in that case, hold an intermediate position, and on these grounds they have been termed Older Pliocene.

Thus far, excluding the scepticism, I have followed Professor Forbes and Captain Spratt, who enunciated the above (apparently) convincing proof of the age of the Cos and Xanthus fresh-water beds in the 'Travels in Lycia' already referred to. From a very brief consideration of the argument, the principle on which it is based will make itself apparent to everyone. The object is to fix a limit in both directions to the age of the strata, or, to use the original terms, to find an 'ante-date' and an 'after-date,'—a process often resorted to by the inquisitive in their efforts to discover the ages of their friends!

If we inquire a little more closely into the basis of the argument, namely, that the inclined position of the marine strata is suggestive of their greater age (which is altogether assumed), we shall find, on reference to the section given below, that they *dip the wrong way!*—and thus a doubt is cast upon the whole of the reasoning. The following explanation will make my meaning clear: suppose the Scaglia and Macigno to be more or less horizontal, and the marine formation to be deposited conformably on it, then suppose the valley to be formed by the elevation of the Scaglia on each side, and to be rendered deeper by the erosion of the marine strata, it is evident that the remaining patches of the marine formation would dip conformably with the Scaglia, not at nearly right angles to it, as in the following section:—

Section across the Valley of Xanthus.—(After Forbes and Spratt.)



a Marine sandy strata (Miocene), dipping *from* the centre of the valley.
b. Conglomerate. *c*. Marl (freshwater). *d*. Macigno.
e. Scaglia (Cretaceous) dipping *towards* the centre of the valley.

On the other hand, if the Scaglia were upheaved, as it evidently was, before the deposition of the marine beds, it is quite impossible that the latter could have been deposited horizontally and afterwards tilted up, because the Scaglia must have been affected at the same time; and if we assume that its dip was lower when the marine beds were formed, the latter must have been deposited almost vertical, which cannot be credited for a moment; and if the marine Tertiaries were deposited in a horizontal position, the Scaglia must formerly have been nearly vertical. Indeed, it is evident that the apparent dip of the marine

beds is due to false-bedding, and not to elevation at all; consequently it is no indication of their being older than the horizontal fresh-water strata.

Again, supposing that the marine beds were the older, they must once have filled up the valley. By what manner of water-action could they have been so completely washed away that no trace of them exists anywhere beneath the fresh-water formation, and only small patches are left high up on the hill-sides, where they could least of all be expected?

Considering all the difficulties in the way of the marine beds being the older, and that there is no physical reason why they should not be the newer (granting the apparent dip to be due to the false-bedding), we may legitimately compare the fossils of the Cos and Xanthus fresh-water beds, with the shells figured in the Plate, without taking into account their supposed Pliocene age, to which view, it will be found, their evidence is entirely antagonistic. It may be remarked, however, that if the fresh-water strata are the older, the lowest bed, in which occur the same genera as Captain Spratt has obtained from Crete, must, according to its fossils, either be very low down in the Upper Miocene, or must belong to the Lower Miocene: perhaps it does not matter which we consider it; but the point I shall now attempt to establish is that our Cretan fossils are of the same age.

Geological Age of the Fossils under consideration.—A glance at the following lists will show that of those from Cerigo, all, with the exception of *Cerithium Cytherorum* (a new species), occur in the Upper Miocene of Europe, while two began life earlier. The balance of evidence is therefore strongly in favour of the Cerigo fossils being Upper Miocene; that is to say, of the age of the Vienna and Bordeaux Basins. The marine formation in Crete, described by M. Raulin, and said to be of Miocene age, may possibly belong to the same set of strata, though his list does not include any of our species, which are less decidedly marine than those enumerated by him.

The Cretan specimens being, however, all different from those of Cerigo, with one exception, require further discussion. *Melanopsis buccinoidea*, the only species common to both sets of fossils, is also one of those which appeared first in strata older than the Upper Miocene, and with it is associated in Crete *Cerithium Lamarckii*, which began life in Eocene times and extended up into the Lower Miocene, but which has not been found in newer strata. On the other hand, we have *Melanopsis Bouei*, representing the Upper Miocene period, and a species of *Unio*, allied to *Unio litoralis*, which tells us very little concerning its age. The remaining species, three in number, are new, and one of them presents some remarkable modifications of form, so that it is rather difficult to form a correct idea of their geological date.

The genus *Unio* contains very many species, resembling one another so closely as to render it very difficult to distinguish them, especially in the fossil state, so that very little reliance can be placed on them as indicative of the age of Tertiary strata. *Melanopsis buccinoidea*, as we have seen, furnishes no clue to the age of beds

in which it occurs, its range being so extended. *Cerithium Lamarckii*, on the contrary, is a well-known shell, which occurs abundantly in Lower Miocene strata, and is found also in the Eocene "Sables de Beauchamp," so that its occurrence would appear to stamp the age of the deposit as Lower Miocene or older, and to the period named I am inclined to refer it, though it is not impossible that a larger collection of shells may prove it to be somewhat newer. But the great difference between these shells and recent species renders it impossible that the deposit should be Pliocene, as has been supposed.

It by no means follows, however, that there is no more recent formation in Crete; on the contrary, M. Raulin, in a paper on the geology of Crete,* speaks of a lacustrine limestone above a marine formation; and a late lacustrine deposit occurring in the plains in the interior of the island furnished him with the lower jaw of a *Hippopotamus*.

The so-called lacustrine formation of Rhodes contains species of *Neritina* and *Melanopsis*, the latter being *M. Bouei;* with it occurs *Cerithium plicatum*, an associate of *C. Lamarckii* in the Paris and Mayence basins. Although the occurrence of *Cerithium plicatum* is, of itself, not antagonistic to the Upper Miocene age of the strata, yet, when associated with *C. Lamarckii*, it seems reasonable to consider them, for the present at least, as Lower Miocene, especially as the only true Upper Miocene species occurring with them is *Melanopsis Bouei*, and the only recent species is *M. buccinoidea*, which occurs in great numbers in Lower Miocene strata also. The only obstacle to the Upper Miocene age of the beds is, in fact, the occurrence of *Cerithium Lamarckii;* and, although there is no reason why that species may not occur higher in the series, yet as it has not been found in that position hitherto, and as the evidence is at present strongly in favour of its Lower Miocene age in Crete, we must consider it for the present limited to Eocene and Lower Miocene strata.

Malformed Shells.—The fresh-water beds of Rhodes are admitted to be of the same age as those of Cos and Xanthus, some species of shells being common to the three localities, and the remarkable *Neritina abnormis* (Figs. 7*a* to 7*e* of the Plate) from Crete being very near the *Neritina* from Cos figured by Professor Forbes,† if not identical with it. The specimens from both islands exhibit the same kind of malformation, showing that the faunæ of both series of strata lived under similar conditions, which appear to have been unfavourable to some of the species

On examination, it will be seen that the older the specimen, the more distorted does it appear, and the larger are the keels on the whorls, and that, at last, tubercles and even spines spring from them. So in Figs. 8*a* to 8*c*, representing a *Unio*, the same kind of result is seen in the great thickness of the shell, and the small size of one of the specimens, and in Figs. 4*a* to 4*c* in the comparative coarseness of the ribs of *Melanopsis Bouei*. The *Neritina* represented in Figs. 6*a*

* Bull. Soc. Géol. de France. Deuxième Série, vol. xiii.
† 'Travels in Lycia,' vol. ii. p. 203.

to 6*d* has escaped this malformation, to a great extent, but still it is not always quite free from distortion.

But the most remarkable shell "cheated of feature by dissembling nature" is shown in Figs. 3*a* and 3*b*; it is turned the wrong way, and this circumstance, with its peculiar ornament, gives it such a singular appearance, that out of twenty shells spread out on a table, a conchologist would certainly take up this one first, as I have verified by experiment. It seems to defy determination. There are two specimens in Captain Spratt's collection, so that its reversal is not accidental, but, with its thickness and coarse ornament, is apparently due to its having lived under unfavourable circumstances. The species is certainly new, and I have called it *Melania* (*?*) *anomala*, though I am by no means sure of its genus.

These monstrous kinds of growth are interesting on many grounds, and especially so in relation to the mode of formation of the deposit in which they occur. Professor Forbes and Captain Spratt described such malformed shells from Cos several years ago in the 'Travels in Lycia;' but some of them belonged to the genus *Paludina*, and others, as in this case, to the genera *Neritina* and *Melanopsis*. The Cretan specimens that exhibit abnormal characters belong to the two last-named genera, and to the bivalve genus *Unio*; but the *Cerithia*, which cannot live in fresh water, are quite normal in appearance.

Malformation as a Test of Habitat.—It is easy to see that malformations of this kind may furnish an important clue to the origin of a formation; for instance, in this case, the most truly marine genus is represented by species exhibiting normal characters, while the more fresh-water genera are distorted; thus it appears impossible to assign a purely fresh-water origin to the deposit, and we shall presently see that this conclusion is borne out by independent arguments.

Nearly fifty years ago, M. Beudant proved by experiment, that of the mollusks which inhabit fresh water, those only which had the power of shutting off all communication between themselves and the water they lived in could resist the action of brackish or salt water; that is to say, only bivalves and operculated univalves could exist at all under such circumstances. Upon *à priori* grounds it is allowable to extend this law, for certain pulmoniferous gasteropods are operculated; but, as they cannot breathe without rising to the surface, and as that process entails repeated contact with the noxiously salt water, it is but reasonable to conclude that they could not long survive such a disagreeable necessity. We may therefore say that all pulmoniferous gasteropods and all non-operculated fresh-water gasteropods are unable to live in salt or brackish water.

But although these bivalve and operculated univalve mollusks could resist the action of salt water for a time, M. Beudant found that even the latter could only live permanently if the water contained not more than 4 *per cent.* of saline matter, and that even this small quantity was sufficient to kill the bivalves after a short time; hence arises the paucity of shells of the genera *Unio*, *Cyclas*, &c., in brackish water deposits.

It will now be possible to discuss fairly the probability of the

fossils in question having been deposited in a lake or an estuary, and this discussion is the more desirable, because the more or less fresh-water formations of Asia Minor, &c., have often been treated of as necessarily lacustrine. The only circumstances necessary to remember are: (1) that the following remarks do not refer to Cerigo, the fossils from thence being normally estuarine; and (2) that in Crete the most essentially salt-water genera are represented by species normal in character, while the fluviatile genera are represented by distorted species.

But to enable us to decide whether we have been dealing with a marine, an estuarine, a fluviatile, or a lacustrine formation, it is now necessary to discuss the distinctive characters of these classes of deposits, chiefly from a palæontological point of view.

Distinctive Characters of Lacustrine, Fluviatile and Estuarine Deposits.—Purely fresh-water strata are nearly always lake-deposits, because a river seldom deposits in its own bed, and when it does, the deposit is so insignificant, that it is rarely preserved; while, on the other hand, the deposit of a river at its mouth, that is, a delta, contains brackish-water shells, generally mixed with those of fluviatile and terrestrial origin. Again, a lake may be more or less brackish, or even absolutely salt; and a lagoon, which is but another name for a lake connected with a larger body of water, may be subject to periodical irruptions of salt water. Thus there are many contingencies to be guarded against in deciding as to the lacustrine or estuarine origin of a series of beds, supposing the fossils contained in them to exhibit characters not antagonistic to the presence of a certain quantity of salt water, especially in the region under consideration, where lagoons are so abundant; but very little difficulty exists if the shells happen to be purely freshwater and normal in character. Of course, there is this difference between a lake and a river, that whereas the water in the former is more or less stagnant, that in the latter is in motion; but a deposit from a river into a lake would yield evidence of both running and stagnant water, and, unfortunately, shells afford but little evidence as to their fluviatile or lacustrine origin. It would, however, be strange indeed if the fossils of a true lacustrine deposit did not consist, to a certain extent, of the shells of pulmoniferous mollusks; and inasmuch as there is not a single shell belonging to that group amongst the fossils under consideration, the theory of a fresh-water lake cannot well be accepted.

Nature of the Crete Deposit.—All the fossil genera under notice from Crete, excepting the genus *Unio*, have existing species which live in brackish water, or even in the sea, so that they are not antagonistic to the estuarine nature of the deposit, though they are equally favourable to its being a salt-lake formation; but as some of the genera cannot exist in fresh water, the beds cannot have been deposited in a fresh-water lake. Again, *Neritina* and *Melanopsis* are essentially the inhabitants of running water, and the genus *Unio* is just as essentially fresh water, therefore if the fossils presented no abnormal characters, the only rational conclusion would be that the Crete formation is a deposit from a river in an estuary.

But we have seen that one species of *Neritina* is keeled and tuberculated, while another presents ordinary characters, that the *Unio* is unnaturally thick, and, except one specimen, very much stunted, while the most abundant species of *Melanopsis* is represented both by small specimens normal in character, and by large examples unnaturally coarse and ribbed, to say nothing of the wonderful *Melania*. How, therefore, can we account for the entombment of species which lived under normal conditions in association with specimens of the same and other species that evidently lived under circumstances not quite suited to them? Bearing in mind that the normal specimens belong both to fresh-water and estuarine genera, and that the abnormal ones are wholly fresh-water, as well as the fact that all of them could exist in brackish water, being either operculated gasteropods or bivalves, and not belonging to purely fresh-water genera, it appears to me that the only way of accounting for the association is by supposing that the deposit was formed in a lagoon, which was subject to occasional irruptions of salt water, and into which a river flowed.

This conclusion is very similar to that arrived at by Professor Forbes and Captain Spratt respecting the Cos fossils, only that they assumed the lagoon to be at first quite fresh, and to have become gradually saline, and they did not call in the aid of a river; but the occurrence of the *Unio* and of normal and abnormal specimens of *Neritina*, &c., appears to render the latter device necessary in this case. In the lagoon, all the species could exist for a time, after having been carried down by the river, and thus the abnormalities described may have been produced.

APPENDIX.

I.—Descriptions of New Species from Crete.

1. *Neritina abnormis*, mihi. Figs. 7*a* to 7*e*.

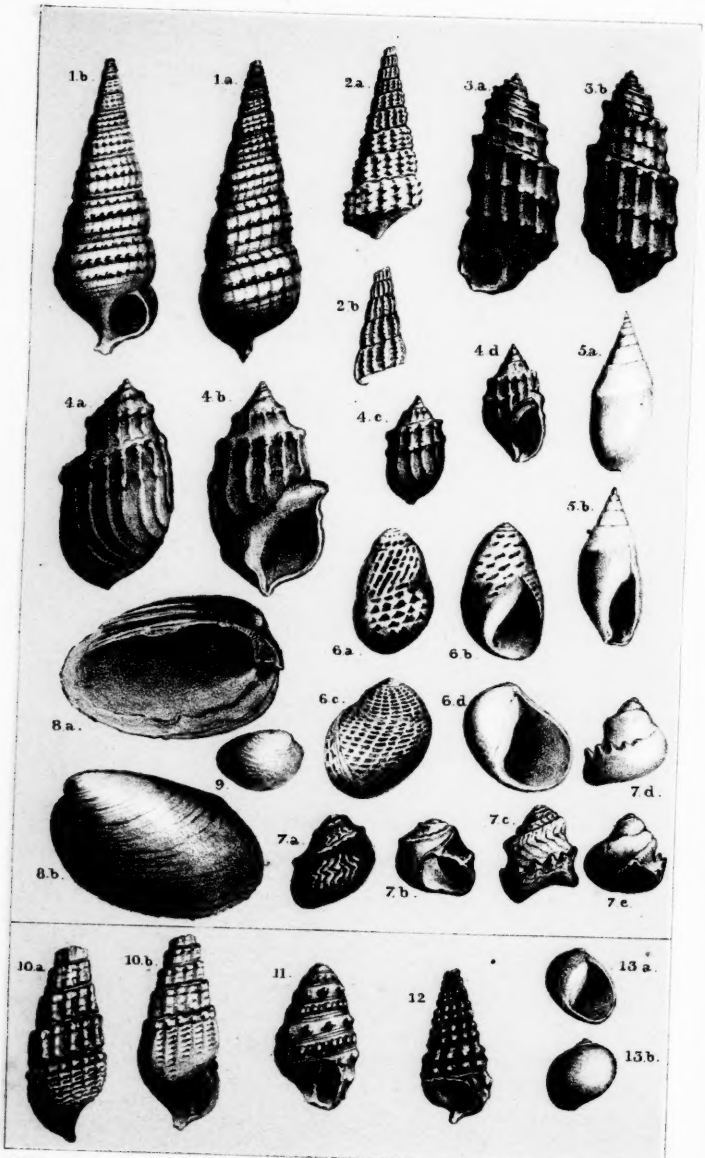
Shell broadly ovate, trochiform, ornamented with brownish zig-zag longitudinal lines or bands; whorls three, crowned by a broad cord-like keel, and with a thinner and sharper ridge in the middle, often corded or crenate, and sometimes tuberculated or irregularly spiniferous, separated from the upper keel by the concave upper portion of the whorl. Mouth in a plane nearly at right angles to the axis, more or less semilunate in form; inner lip concave, smooth, with a broad callosity covering the base of the shell, and becoming very thick and encroaching on the mouth in old specimens.

2. *Neritina Spratti*, mihi. Figs. 6*a* to 6*d*.

Shell ovate, smooth, ornamented with many blackish spots, more or less regularly arranged; whorls three or four, declining above, sometimes compressed in the middle, convex at the base. Spire depressed, blunt. Mouth oblique, irregularly semilunate in form; inner lip concave, callous, minutely dentate.

3. *Melania? anomala*, mihi. Figs. 3*a*, 3*b*.

Shell thick, reversed, turreted, ovate, somewhat obtuse at the apex; whorls about seven, slightly convex, transversely and longitudinally ridged; transverse ridges coarse and blunt, obsolete on the uppermost whorls, and gradually increasing in number, from two on the third whorl to four on the body-whorl; longitudinal ridges obsolete on the upper whorls and becoming gradually more apparent on the lower; they are the same distance apart as the transverse ridges, which they



H.M.Jenkins del. M.&N.Hanhart imp. De Wilde lith.

BRACKISH WATER FOSSILS OF CRETE & CERIGO.

cross at right angles, forming a tubercle at the point of intersection. Base of the shell similarly ornamented and slightly umbilicate. Mouth oval; columella thickened; inner lip callous above; callosity flat, thin, spreading over part of the base of the shell above the small umbilicus.

4. *Cerithium recticostatum*, mihi. Figs. 2*a*, 2*b*.

Shell turreted, acute: whorls numerous, slightly convex, ornamented with three sharp transverse ridges, crossed at right angles by about ten straight, sharp, very prominent, and almost lamelliform varices, which are slightly tuberculated at the point of crossing, and also just below the suture, where they are crossed by a fourth and very small longitudinal ridge. Mouth oval, effuse at the base, where the peristome is prolonged into a pointed spout.

5. *Unio Cretensis* mihi. Figs. 8*a to* 8*c*.

Shell very thick and coarse, sub-rhomboidal, with the upper margin convex, and the lower almost straight; anterior extremity rounded, scarcely projecting beyond the umbo; posterior extremity obliquely projecting, very convex, almost pointed, ending above in a sharp angular ear; umbo prominent, scarcely eroded. Hinge-teeth and lamellæ very thick and projecting; anterior muscular impression very deep, much deeper than the posterior.

II.—Description of a New Species from Cerigo.

Cerithium Cytherorum, mihi. Fig. 11.

Shell turreted, acute: whorls numerous, convex, ornamented with two convex transverse bands, which are separated by a sharply-defined shallow groove, and are tuberculated where crossed by the varices; varices curved, broad, not very distinct; suture neatly impressed, slightly undulated. Mouth small, nearly round; columella callous, twisted, and somewhat produced, oblique. Base of the shell ornamented with about five parallel ridges crossed by distinct lines of growth.

EXPLANATION OF PLATE.

Fossils from Crete.

Figs. 1*a*, 1*b*.—*Cerithium Lamarckii*. Magnified 2 diameters. From the plain of Arkadia.
„ 2*a*.—*C. recticostatum*. Natural size. From Kherisoniso.
„ 2*b*.—*C. recticostatum*, var. Natural size. From Kherisoniso.
„ 3*a*, 3*b*.—*Melania? anomala*. Magnified 2 diameters. From Kherisoniso.
„ 4*a to* 4*c*.—*Melanopsis Bouei*. Magnified 2 diameters. From Kherisoniso.
„ 5*a*, 5*b*.—*Melanopsis buccinoidea*. Natural size. From the Plain of Arkadia. This species also occurs in Cerigo.
„ 6*a to* 6*d*.—*Neritina Spratti*. Magnified 2 diameters. From Kherisoniso.
„ 7*a to* 7*c*.—*N. abnormis*. Magnified 2 diameters. From Kherisoniso.
„ 8*a to* 8*c*.—*Unio Cretensis*. Natural size. From Kherisoniso.

Fossils from Cerigo.

Figs. 9*a*, 9*b*.—*Cerithium plicatum*. Natural size.
„ 10.—*C. doliolum*. Magnified 2 diameters.
„ 11.—*C. Cytherorum*. Magnified 2 diameters.
„ 12*a*, 12*b*.—*Neritina fluviatilis*. Magnified 2 diameters.

XUM

ON THE HISTORY AND USES OF THE OPHTHALMOSCOPE.

By Thomas Nunneley, F.R.C.S.E., &c.

Though the present age may not be so distinguished for any very brilliant discovery or startling scientific invention as were some of those which are gone by, it may be doubted if there has ever been a period in the world's history in which work likely to advance knowledge and benefit mankind was more heartily, honestly, or generally pursued than at the present day. If the rewards have not been so great to one or two individuals as to overshadow and obscure the gleanings of all the other labourers, the progress made in precise knowledge and the adoption of scientific precision has certainly never been more marked. The result is a steady progress, even in those departments of knowledge which heretofore have been considered as rather speculative than positive, or as belonging more to art than to science. The known laws of one branch of science have not unfrequently been applied with great ingenuity and success to the practical elucidation of obscure phenomena in other departments. Of this advance the instrument, the name of which is placed above, and the employment of which has recently been introduced into the investigation of diseases of the eye, affords a very good illustration. In drawing attention to it, we do not intend to enter upon a detailed criticism of the various appearances, and the minute shades of difference which the ophthalmoscope reveals, inasmuch as the subject, technically treated, belongs to the domain of pure medicine, and would be neither interesting to, nor be understood by, the general reader. Indeed, it is very possible that many persons have not as yet heard of the ophthalmoscope by name, and very certain that of those who have, many more have but little knowledge of its application. Indeed, so novel is the instrument, and so recondite are its revelations, that we might say, as yet, it has been very partially employed by only one section of the medical profession. Doubtless the time will soon arrive when more will have been learnt by those who now use the instrument, and its employment be more widely distributed.

We propose rather, as briefly as possible consistent with intelligibility, to give such an account of the instrument itself, the principles upon which its action is founded, and the objects which its use is likely to reveal, as may be sufficient to keep the general reader *au courant* with the scientific inventions of the day, even though such inventions may belong exclusively, in the first instance, to one section of the community: we say in the first instance, for, without doubt, in the long run every improvement in the means of diagnosing and rendering clear and indubitable, diseases, in whatever part of our bodies they may be seated, which heretofore have been most obscure and dubious, is of permanent interest to every person. This is especially the case with diseases of the eye, the

neglect of which is of such fearful consequence to the sufferer. Now it is precisely this serious class of most obscure changes in the deeper, more delicate, more important, and most hidden recesses of the eyeball, that the ophthalmoscope is destined to light up and reveal with a clearness which will remove most, if not all, of the obscurity which has hitherto concealed them. During the last century no branch of medicine has made greater strides towards attaining scientific precision than has ophthalmic surgery, which has been rescued from the hands of the impudent charlatan and the wandering mountebank, to become in many respects the most advanced branch of practical medicine; yet it must be admitted by everyone, who from attention to the matter is qualified to give an opinion on the subject, that it is in precisely these more important diseases of the eyeball, (in which it is of the utmost consequence to attain an early knowledge of the kind of change which is going on, and the particular structure in which it is taking place,) that hitherto there has been the greatest difficulty in so doing. The outer structures of the eye are within reach and amenable to the examination of everyone; not so the inner. In the earlier stages of disease in these, when examined by the ordinary method, there are often no objective symptoms, while the subjective phenomena are so obscure and confused, as to be not unfrequently of little certainty or value. Hereafter, the ophthalmoscope promises to, nay, certainly will, remove much of the obscurity, and it cannot fail to render the diagnosis of these terrible and insidious changes in the deeper seated tissues of the eye almost as much within the sight of an expert observer as are those in the most superficial parts; and by thus enabling the competent oculist to detect the earliest indications of change (which hitherto has been too frequently beyond his power of observation), it will allow him, by timely treatment, to prevent alterations, which would otherwise, if unobserved, progress until all chance for good being effected has passed away, and hopeless blindness has become the inevitable lot of the unhappy patient. In many of these changes, if far advanced, there is no cure; in them prevention is not only better than cure, but it is emphatically the only cure.

Though it is barely a dozen years since the ophthalmoscope began, in the hands of Brücke and Helmholtz, to assume a form of practical application, the idea of such an apparatus, or rather the principle upon which such a method of examining the eye depends, was first clearly indicated by one of our own countrymen, Mr. Cumming; who, in an admirable paper, published in the 'Medico-chirurgical Transactions for 1846,' clearly pointed out the importance of observing the light which is reflected from the bottom of the eye, and suggested the circumstances under which the interior of the eye itself might be examined. It now appears astonishing that Mr. Cumming's observations, leading not very remotely nor indirectly to the invention of the ophthalmoscope, did not at once excite more attention; but it is perhaps still more wonderful that the mirror-like reflexion from the bottom of the eyes of cats and other animals, which must have been seen by the learned and unlearned, almost ever since the creation, should not have suggested the idea long ago: for

in it is the very germ of the subject; light falling upon the concave bottom of the eye of these animals is reflected, and causes the luminous appearance by which the fundus of the eye, in certain positions of it, is seen: only place any other animal, man included, in favourable circumstances, and the same appearance will be observed.

Dilate the pupil, so as to allow the rays of light freely to pass into and out of the eye; let the eye be placed in a suitable position for the rays of light from a luminous body to fall upon it, in a chamber from which all the light is excluded; and let the observer stand in a proper position, which is "as nearly as possible, in a direct line between the source of the light and the eye to be examined . . . . when the luminosity of the interior of the eye will be immediately perceived;" these, as stated by Mr. Cumming, are directions which really comprise the principles upon which the ophthalmoscope must be constructed and used.

Helmholtz's first instrument was a square box, with a darkened interior, containing three parallel plates of glass, placed obliquely at one end, and at the other, one or two bi-convex lenses, to concentrate the rays of light; but the image thus afforded was too faint to be of much value, as most of the light was lost by the intervening plates. A great improvement was shortly afterwards made by the introduction of a concave, or a plane-reflecting mirror, which, though it has been variously modified in shape and mounting, or in the method of being held, constitutes in one form or other the various forms of ophthalmoscope now used; the modifications being rather according to the fancy or the whim of the party using it, than involving any difference in principle. Suggestions have lately been made for a binocular ophthalmoscope, which it is asserted possesses advantages which the single reflector does not, but there is a difficulty in getting a correct focus with it, and the instrument has not obtained general adoption. Leibrich has invented a large and somewhat costly apparatus, with various tubes, rods, and supports for more accurately adjusting the focus, supporting the head of the patient, and fixing the eye under observation: this is said to accomplish its object satisfactorily, but from its being a fixture and cumbersome, is not much used. The instrument almost universally employed, at least in this country, is a circular, slightly concave, mirror about two inches in diameter, having a central aperture of $\frac{1}{6}$ to $\frac{1}{8}$ in. diameter, which, at the pleasure of the observer, may be mounted on a stem, or simply held in the hand, and may be made of speculum metal, of polished steel, or, as is most common, of silvered glass. By this mirror the rays of light are received and reflected upon the patient's eye. The mirror is held close before the observer's eye, with its aperture corresponding with the centre of his own pupil; by this means his own eye is in a great degree protected from the light, while through the aperture he has a full view of the illuminated disk of the patient's eye. The central aperture in the mirror should be of sufficient size to allow of this observation, but no larger, for of course, at this spot, there is no reflection of light: indeed, through this orifice, the bright light, which should all be reflected as nearly as possible, may find

admission into the observer's eye, and thus the experiment is interfered with in two ways. With the mirror, is frequently used a double convex lens of about two inches focus, which is held between the mirror and the eye to be observed, for the purpose of concentrating the rays of light before they fall upon the observed cornea. This lens is necessary when the observed eye is flat, or presbyopic; but when the cornea is convex, or myopic, the rays of light will fall upon the retina with sufficient accuracy, without other concentration than the eye itself is capable of affording.

For making the observation, the eye to be operated upon should have had the pupil well dilated by the introduction of atropine; for unless this is done, sufficient light will not enter the eye to be reflected from the fundus and render the illumination clear, nor will the field of vision be sufficient to enable an examination to be made of the whole interior, and disease may likely enough exist, which lying behind the undilated iris must necessarily escape observation. The patient should then be placed in a darkened room, and directed to hold the head as steady as possible with the eyelids widely open, and the eyes looking directly forward fixed as immovably as possible. If a strong illumination is not required, a wax-candle, or if it be necessary, an argand gas-burner, or a camphine lamp, must be placed a little behind, and at the same side of the head as is the eye to be examined, and on the same level as the eyes. The observer then places himself directly before the patient, bringing his eye with the mirror held before it, as nearly as he can in the same plane with the patient's eye, when the rays of light, falling upon the mirror, will be reflected as a diffuse circle of light; this, by adjusting the position of the mirror, may easily be so focussed as to fall directly upon the dilated pupil, when a brilliant illumination of the fundus of the eye will be obtained, and of course any abnormal condition of its various parts may be at once observed. A more interesting and striking picture can scarcely be imagined than a brilliant view of the blood-vessels of the retina and choroid coat of a healthy living eye. Neither do we know of a more beautiful and simple application of optical science, nor of one which is more rich in the advantages which it is likely to confer upon mankind. To those familiar with the more simple of optical laws, the mode in which this image is obtained, will be at once so obvious as to require no explanation; while it would hardly be possible, without the aid of diagrams and a larger space than we can spare, to render it intelligible to those who do not understand them.

We must, however, guard our readers against at once jumping to the conclusion, that because it is now easy for any competent observer to see clearly into the very bottom of the living eye, it is therefore easy to make the observation useful. None but a skilful anatomist and physiologist can do this; inasmuch as he must first not only know of what the marvellously minute tissues of the interior structures of the eye consist, but he must also, by patient and repeated observation, have rendered himself familiar with the appearances which this healthy condition presents under examination with the ophthalmoscope, before he can venture upon the attempt at discriminating between

them and those which result from altered and abnormal conditions of the tissues; and after he has arrived at this knowledge he must further learn by frequent examination and careful reasoning, to determine not only in which particular structure the change may be, but the exact nature of the change and the stage of it, whether it indicates an altered condition of a temporary unimportant character, or a morbid state of a more permanent or even irremediable kind; whether the disease be in an early stage, with commencing mischief, or at a period of decline, when any change which is likely to result from it has already been accomplished. He must further know whether any treatment (and if any, of what nature) is likely to be beneficial; or whether the change involves such organic alteration in the structure of the part, that no remedies can benefit: even further information may be obtained if this latter condition be established, for we learn whether the disease be such as may be limited to the eye or may extend to the whole system, ultimately destroying not only the organ itself, but the life of the patient. It is upon the answers given to these, and similar important questions, that the knowledge revealed by the ophthalmoscope is destined to be of the utmost value. We say advisedly "destined to be," for though fully prepared to recognize the great steps in advance, which the diligence of comparatively few observers has secured, and to acknowledge that many of the more clearly marked diseases are already readily diagnosed, it must be confessed that much still remains to be done; there is still much to be learnt, and something to be unlearnt. For ardent minds will dogmatize on insufficient data, and inexperience is apt to overlook difficulties which stand in the way of those who know more; while ignorance will not unfrequently hazard a rash assertion rather than confess to a want of experience in the use of an instrument with which a patient, having heard something wonderful about it, expects, as a matter of course, that the party he consults should be perfectly familiar. We could cite examples of strange assertions and crude speculations which have been made after gravely peeping through an ophthalmoscope. This, however, is no valid argument against the value of the discovery itself. The difficulty of acquiring any technical knowledge, sufficiently precise to be valuable, is often great; far more so than many people suppose. No greater advance in the means of detecting and distinguishing diseases of the chest has ever been made than through the invention of the stethoscope. Now what this simple instrument is to the chest, the ophthalmoscope is and will be to the eye. It has required nearly fifty years of diligent observation, and the labour of thousands of learned men over almost the whole world, to define the revelations of the stethoscope as now understood by the initiated, and still there are multitudes who make a show of using it, but do not understand its teachings. So it is, and probably long will be, with the ophthalmoscope.

Appearances which are not now understood, will ere long have their true significance shown to those who will take the trouble to learn; and errors which are now committed will be avoided, while accumulated experience will clearly indicate the value of that which is now ob-

scure. It is not unlikely that improved forms of instruments may be suggested, by which even more perfect views than can now be got of the fundus of the eye may be obtained; and instruction in their use will become so common, that it will be regarded as a necessary part of the duty of those who undertake the especial treatment of diseases of the eye, to obtain as familiar an acquaintance with the use of the ophthalmoscope as they are now obliged to have with the instruments used in the performance of physical operations, or as the physician to the hospital for diseases of the chest must have with the stethescope. Already a suggestion has been made by a Canadian to add to the ophthalmoscope an apparatus by which photographs of the bottom of the eye may be obtained: this, though not at present of practical avail, may not unlikely become so ere long.

When it is considered how short a time has elapsed since the power of seeing into the bottom of the living eye was demonstrated to be practical, it is satisfactory to know how much has already been accomplished in rendering the knowledge useful in the treatment of diseases there seated.

It is not intended to be asserted that it will ever become very easy to determine by the ophthalmoscope the value of all the changes which take place in the living eye, any more than it is to become a learned astronomer, or to acquire any other knowledge which involves the possession of intellect, and the expenditure of labour; but to those who possess the one, and will undergo the other, the ophthalmoscope is, and will be, of the greatest value. Medicine is daily becoming more of a science, and those who care to keep pace with its progress will have to do so by the study and adoption of those means of which the stethescope and ophthalmoscope are illustrations.

ACCLIMATIZATION.

By Dr. C. COLLINGWOOD, M.A., M.B. Oxon., F.L.S.

WE recollect hearing a distinguished English Zoologist not long since assert that, notwithstanding all the Societies devoted to this object, and all the assiduous care which had been bestowed upon the deportation and breeding of animals, with a view to adapt them to their new homes, no successful instance of acclimatization could be produced by the supporters of the system. But either the veteran systematist must have made a false estimate of the true nature and objects of acclimatization, or he must have judged of the facts by too narrow and procrustean a rule; for no one who is acquainted with the efforts and the proceedings of the two great Acclimatization Societies, those of Paris and Victoria, can believe that the sums expended, the energy evinced, and the interest aroused by them, can be for a mere visionary and shadowy object. The reports which are issued by these Societies from time to time display an amount of successful enterprise, which is a subject of just congratulation, and we cannot but wish prosperity to aims which are at once useful and philanthropic, and which, in some cases, are re-

deemed by a touch of romance from the ordinary utilitarian ends of similar undertakings.

Among the useful animals to which the Société d'Acclimatation* have directed special attention, the yak is conspicuous, a native of Thibet,—a creature possessing a most valuable skin or fleece, and which is found to breed very readily in the garden of the Society; and, although it at present yields but little milk, it is hoped that in time, the influence of domestication may render it more valuable in this as in other particulars. Several prizes are offered for the breeding of these animals, *viz.*:—two prizes of 2.500 francs each, for anyone who shall produce by the 1st December, 1865, four yaks of pure blood, of a year old, and of his own breeding; also other prizes of 1,800 and 1,200 francs, for crosses between yaks of pure breed and mountain cattle (vaches de travail); as well as smaller prizes for such animals as shall prove apt as beasts of labour or of burden.

Similar experiments are in course of trial upon Angora and Egyptian goats, Caramanian and Merino sheep, &c., which are reported to be in a fair way to success; and encouragement is held out by prizes of various amounts, for the production of small flocks of these animals, for the purest breed, and the heaviest producible fleece.

The gathering together in good condition, and in sufficient numbers to establish a species, of foreign animals and plants is necessarily a very slow and delicate process, and much time must obviously be expended before very decided results can be expected. Most of these animals breed only once a year, and their natural increase is, therefore, slow, however eminently they may prove themselves adapted to their new home. Nor is it to be expected that every experiment of the kind should be at once successful. We should regret to see an energetic movement damped by temporary misfortune, and we trust that the ill success attending the first attempts (in 1860) at the introduction of Llamas and Alpacas into France will only be a difficult stepping-stone to the accomplishment of a task of great importance, both in an agricultural and economical point of view.

A second attempt is already contemplated, and the Presidents of Peru and Equador have offered two troops of these animals, and M. St. Hilaire has published a paper relating the causes of the recent failure, with instructions as to their treatment with a view to avoid such failure in future.

Similar attempts are being made to utilize the wild ass, and

* The Imperial Zoological Society of Acclimatization publishes a monthly 'Bulletin,' the numbers of which are now before us, and contain a great deal of most interesting matter ('Bulletin Mensuel de la Société Imperiale Zoologique d'Acclimatation.' Paris: Masson & Fils). The object of this Society (which has been founded ten years) is to co-operate "for the purpose of introducing, acclimatizing, and domesticating species of animals which are either useful or ornamental, and the improvement and multiplication of races newly introduced or domesticated. The Society also occupies itself with the introduction and cultivation of useful vegetables." M. Drouyn de Lhuys, the Foreign Minister, is President of the Society, and its council includes the names of Passy, Richard, Dupin, Cloquet, Dumeril, Quatrefages, and others; while it also enjoys a peculiar share of the Imperial countenance and patronage.

Burchell's zebra, quagga, &c., and prizes for the successful breeding of these animals in a state of captivity or domestication are offered, as well as for crosses between them and the mare and the ass.

Among birds, the ostrich has been introduced and domesticated in Algeria and in the south of Europe, and prizes of 1,500 francs are offered for the possession of flocks of these birds, bred by the owner. Attempts also are being made with the cassowary of New Holland, and the American rhea, the crowned pigeon, the ocellated turkey (Meleagris ocellata), Californian quail, &c.

We have not alluded to a Society which exists in London of a similar character, not because it is unimportant, but rather because we wished to call attention to the extensive scale upon which the Societies of Paris and Melbourne are engaged. The most important work of the London Acclimatization Society is in the matter of Pisciculture. Of this Society Mr. Frank Buckland is an active member, and his exertions in the cause of fish-hatching, and the preservation, rearing, and introduction of valuable fish in the rivers of this country, must be appreciated by everyone. The recent discovery of a fine salmon, which had revisited the Thames, makes us hope that the labours of the pisciculturists will be aided, as far as the metropolis is concerned, by the great works which have been undertaken for the purpose of purifying the river, and we trust that attention is now sufficiently aroused to the necessity of protecting a single fish like the salmon, to prevent that extirpation of it which a short time since seemed but too probable. Nor should we altogether omit to allude to the success which has attended the efforts to cultivate oysters.

The French Society have also largely devoted themselves to these subjects, and we regret that our space will not permit us to enter more fully upon these labours. Several valuable papers upon Pisciculture appear in the first series of 'Bulletins,' with the names of Vallenciennes, Gillet de Grandmont, René-Caillaud, Lamiral, &c., attached.

The cultivation of the silkworm has also attracted much notice, and in this department the name of M. Guérin-Méneville stands conspicuous. Several species have been introduced into France, and largely supplied with the trees which are their natural food. Among these are the Bombyx Cynthia, or Ailanthe silkworm, and more recently the Ya-ma-mai, or oak silkworm of Japan. The latter have been introduced at some risk by M. Pompe van Meerdervoort, Director of the Medical School at Nagasaki, who procured a number of eggs, the exportation of which is strictly prohibited by the Japanese, which have been reared in France successfully; and it is believed that this important insect, which lives upon the leaves of the common oak, will support the variations of our climate without much difficulty. The Chinese oak silkworm (Bombyx Pernyi) has been imported also, but the experiment of rearing it has for the present failed.

The popularity of the subject of acclimatization is well illustrated by the prominence lately given in our leading journal, to a report about to be issued by the Acclimatization Society of Victoria; and it is their experience that paragraphs referring to the proceedings of the Society attain a circulation more general than almost any other subject

in English and foreign newspapers. And although the Society to which we are now referring is the one best known, and whose results have been most tangible, as their efforts have been most unwearied, it may be mentioned that amongst its fruits, perhaps, may be reckoned numerous other such Societies which have taken that of Victoria as their model; so that they now exist in almost every colony in those seas, as at Sydney, Hobart Town, Adelaide, Brisbane, Auckland, Lyttleton, and Dunedin. The French Society, too, have established most cordial relations with that of Melbourne, and a French man-of-war is at the present time engaged in transporting thither specimens of the yak, the ostrich, and other animals. Moreover, the British Government has recently been induced to take up the project with an amount of consideration altogether without precedent, the foreign and colonial offices having recently sent to British emissaries in all countries in the world, a series of questions as to the various desirable natural products of each country: and the Admiralty has issued a circular to all commanders of Her Majesty's ships, directing them to render every service in their power to the cause of acclimatization, in the conveyance of specimens.

The inauguration of the Acclimatization Society of Melbourne on its present footing is comparatively recent, since less than three years have elapsed since it was amalgamated with, and undertook the duties of the Zoological Committee. Its Council is composed of gentlemen engaged in commerce, who willingly devote much valuable time to the subject, under the Presidency of Mr. Edward Wilson, the founder of the Society, and to whom has just been awarded the great Gold Medal of the Paris Society, which was instituted in 1862 for the traveller who, during nine years, had rendered the greatest services to the cause of acclimatization. Since the amalgamation, in consequence of the increasing number of animals and the unhealthiness of the original site of the gardens, an entirely new establishment has had to be formed in the Royal Park, involving a very heavy expenditure in fencing, planting, forming excavations for ponds, building a house for the superintendent, shelter-sheds, pens, &c., and the Society now ask for a subsidy from the colonial government. Among other items laid upon the table of the Assembly, 3rd February last, was one of 4,000*l.* for the Acclimatization Society, coupled with a condition that 650*l.* should be raised by private subscription. It is to justify this vote that the Society has published the results of its efforts, in order to prove to the Government that the public money is being legitimately spent, as well as to create a wider interest in the object of the enterprise.

The herd of Camels brought from India, at an expense of 120*l.* per head, had become scattered, and were in a fair way of being annihilated under the various exploratory expeditions. Such of them as could be saved have been collected at Mr. Wilson's station, at the Wimmera, where they are now breeding regularly, and forming the nucleus of probably a large herd, available at some future day, either for exploration or for conveying the products of remote stations to the more arid districts.

Reports have reached us of the failure of the first attempts to

naturalize the Peruvian Alpaca, and out of 300 introduced, five years since, from Peru, and purchased by the New South Wales Government for 15,000*l.*, all have died, and their progeny, 330 in number, are in an unhealthy condition—so much so that in the colonial legislature it was determined to get rid of the cost of keeping them, and disposing of them at once, by auction or otherwise. But on the other hand the official report of the Society prepared in the present year shows that another attempt is likely to have a more successful issue. It is there stated that the little flock of llamas and hybrids imported from England, and under the care of Mr. Duffield, have been diligently cared for. They have been crossed with pure alpacas, and young ones of the second cross are now being dropped. Since landing, their numbers have increased from 19 to 56. Thus, while the Camels suffered from being too greatly scattered, the Alpacas failed from too great concentration.

The Angora goat has been received from the Paris Society, and is rapidly multiplying; they are being crossed with the common goat in considerable numbers. The Cashmere goat also has been imported by an enterprising gentleman at Maryborough, who is now experimenting with it. Various breeds of sheep, some of which show signs of a peculiar adaptability to a hot climate, are also under experiment. The fallow deer, the Indian elk, and the axis have been successfully imported, bred from, and turned loose at Wilson's promontory and other places. Numerous specimens of the hog-deer of India, and other species from Manilla and Formosa, are also in the Society's possession for similar purposes.

With regard to game, the hare has been sent by the Zoological Society of London, and has been turned out on Philip Island, where it is breeding freely. Various breeds of pheasants, partridge, grouse, and quail have been introduced, and some liberated. The English wild duck has multiplied very freely. The Egyptian goose has bred, and promises to be thoroughly acclimatized. So also the wild peafowl of Ceylon has thriven and bred, while the white swan and various kinds of foreign doves and pigeons have been introduced and liberated in various localities.

Among fish, the salmon has been the object of considerable pains and expense on the part of the Tasmanian legislature, and promises well. The gouramie, represented as the best fresh-water pond-fish in the world, has, after many trials, been introduced; and carp, tench, roach, dace, and gold fish have been distributed in various localities favourable to their multiplication. Grey mullet and the edible crab have also been introduced, not, indeed, in sufficient numbers to justify a hope of establishing the breed, but amply suggestive of what will be done in the future.

The Ligurian bee, from its industrious and wonderfully prolific qualities perhaps the most valuable insect in the world, is multiplying with almost incredible rapidity, and will soon be accessible to all classes.

One of the most interesting features of this Society's work is the estimate by which value is determined. They do not limit their in-

quiries to objects of immediate or material usefulness. They do not ask simply, whether certain animals are good eating, or otherwise adapted for daily use, but they consider that the eye and the ear should be gratified also, and that everything is worth securing which adds cheerfulness to scenery, and revives home associations on colonial ground. The introduction of insect-destroying birds is, it is true, an object arrived at; but with this has been combined an effort to surround colonial residences with such reminders of the old country, as thrushes, blackbirds, skylarks, starlings, chaffinches, and sparrows.* The goldfinch, greenfinch, linnet, yellow-hammer, ortolan, bunting, robin, and canary, and many kinds of the smaller birds of other countries, as the Chinese sparrow, Java sparrow, and the Indian mino, are being accumulated in the aviaries of the Society, and many of them have already bred there. The nightingale and the hedge-sparrow have been promised them by ladies at home, and the Queen herself has made an effort to supply them with the rook. Such news may be surprising to the farmers of this country, who mercilessly destroy the very birds which our wiser antipodean brethren are seeking to introduce: but such is the fact, and we believe the Australians are right.

In concluding this brief survey of a subject of so great and increasing interest, we ought to do full justice to the aims of the Australian Society, who regard the advantages of acclimatization in a light which raises it above a mere utilitarian and commercial speculation. Deprecating the sneers and misrepresentations of thoughtless and ignorant persons, who have no conception of the varied objects and considerable interests which it embraces, they openly state their object in stocking their country with new, useful, and beautiful things to be, not only to add to the national wealth—not only to suggest new forms for colonial industry, but, also to provide for manly sports, which will lead the Australian youth to seek their recreation on the river's bank and mountain side, rather than in the café and casino. Nor do they stop at this praiseworthy avowal; we have alluded to a touch of romance in their undertaking, and it is not everyone who, endowed with a commercial mind and deeply engaged in the practical business of life, will fully enter into the desire the colonists express, not only to add new elements to the food of an entire people, but also to surround every homestead, and the path of every wayfarer, with new forms of interest and beauty. This is their unwonted aim, and we cannot but rejoice that such a truly poetical feeling should mingle with the sterner and more practical realities of the system. Such a body may well claim the sympathies of every good man, on the ground that they are engaged in a noble work, and we most cordially wish them God speed in their useful and humanizing undertaking.

* In 1830 a merchant wishing to import sparrows to the Havanna, found on arrival that the customs duties were so heavy that he could not hope to sell the birds profitably; he therefore let them fly—the birds entered the island free of duty, and at the end of some years their number was so much increased, that in certain localities they are as numerous as they are at home. (Graells, delegate of the Acclimatization Society at Madrid.) This fact is an encouragement to the Australian movement.

COPPER MINING IN TUSCANY.

Account of the Copper Vein occurring in Tertiary Volcanic Rock worked at the Mine of Monte Catini in Tuscany.

By Professor D. T. ANSTED, F.R.S.

THE copper mining of Tuscany has within the last quarter of a century assumed considerable importance, and more than one of the great mining successes of the time has been gained there. The position and circumstances of the mineral veins that yield these supplies are peculiar, and differ much from the cases with which miners are familiar, not only in England but in Europe generally. At the present time, when everything within the range of the Italian Government is accessible to our countrymen, it is well that a knowledge of these sources of mineral wealth and great scientific interest should be widely known. I make no apology, therefore, for offering a few notes on the subject, collected during a visit I paid to Tuscany last autumn.

The river Cécina is one of the largest of several small streams that take their origin in the tertiary hills west of the valleys of the Arno and the Tiber. These streams, after crossing a few miles of tertiary rock, through which here and there picturesque hills seem to rise up without any reference to the surrounding country, enter the Mediterranean in the flat alluvial tract extending almost uninterruptedly from Leghorn to Cività Vecchia. They traverse a country, parts of it covered with vegetation at certain seasons, but many parts almost startling from their extreme bareness and desolation. In these places, and indeed everywhere in this part of Italy, the effect of the last heavy rains is always traceable on the loose sands of the valley and plain, and at intervals we find fissures from which issue hot, sulphurous vapours. Formerly there were numerous small lakes or lagoons of muddy water boiling vehemently. The low plains were redolent of the disagreeable odour of rotten eggs, owing to the emanations of sulphuretted hydrogen gas, and carbonic acid gas issued in great quantities from certain crevices. The soil was loose and dangerous, and sheep, cattle, and pigs, and even human beings were frequently buried in the treacherous and shaking soil. Within the last thirty years the country is much improved. The vapours have been utilized in a double sense, for vast quantities of borax are now economically manufactured by taking advantage of the natural heat of the streams and springs to evaporate the solutions of valuable salts that abound in the district.

The axis of the fissures that yield both borax and the hot vapours is parallel to that of the Apennines, and also to that of a number of eruptions of serpentinous rock in Tuscany. It agrees, further, with the direction of several recent earthquakes in Italy. Fissures in the serpentine rock itself, and also in the rock immediately adjacent, contain numerous minerals, and among them some ores of copper of very great importance. One of the veins is worked in the mine of Monte Catini to great profit, and under very interesting conditions. Others are

worked in the Val Castrucci, in the Maremme, near the coast, and in this latter case there is evidence that the ancient Etruscan inhabitants of Italy were able to take advantage of the minerals there found. In the Massa Maritima, the veins traverse the tertiary rock of the district. They range from N. W. to S. E. The veinstone or earthy mineral accompanying the ore is usually quartz. The veins are wide, the principal one measuring from 30 to 50 feet. The terrible miasma of the 'Maremme,' as the marsh lands of this part of Tuscany are called, is a serious drawback to working the mines of this district.

Besides the open fissures containing ore, found in the sedimentary rocks themselves, there are dykes, filled with volcanic rock of the nature of basalt, traversing the same rocks, and in some of these copper has been worked from time immemorial. The greater hardness of these dykes compared with that of the sedimentary rock, has helped to preserve the latter from the action of the weather, and thus to leave hills of which the dykes in question are a nucleus. Although but a short distance from the coast, where a few hours' exposure to the evening air is sufficient to induce a fatal attack of malaria fever, the villages on the hills are quite healthy, and near Campiglia, one of these villages, is a fine old Etruscan mine from which copper ore has been taken on a scale worthy of the old Etruscan population whose works of more than one kind have endured longer than history can record. At present the ore is poor though abundant, but doubtless in ancient times there must have been good reasons for the construction of excavations that more resemble huge natural caverns than ordinary mining work. That these excavations were only made when something was to be gained by them is evident from the extremely small proportion of the levels or mere galleries of communication. The rock is very hard, and the labour required must have been prodigious.

The rock in which the copper ore is found in this mine is partly the ancient lava, but partly also the rock penetrated and altered by it. Thus, occasionally, there is a marble floor to the vein, and the limestone intersected by the original fissure seems to have been converted into this marble by the irruption of the heated matter to which the dyke owes its origin.

The very important mine of Monte Catini is another curious instance of the same kind. It is situated in an altered lava close to a boss of trachytic rock a few miles west of Volterra, and some distance north of the Massa Maritima. The distances indeed between the points hitherto described is somewhat considerable, though all are intimately connected by geological links. Thus Campiglia is 15 miles west of Massa, and Monte Catini about 25 miles to the north of both. The coast railway from Leghorn, open at present to Follonica on the way to Cività Vecchia, has, however, rendered all these places much easier of access than they formerly were. There is a branch of the main-line running up the Cécina towards Volterra for the benefit of the borax works and the Monte Catini mine. Close to Campiglia is a much larger mass of trachytic rock than that near Monte Catini, but no doubt answering the same purpose. Both at Campiglia and Monte Catini, the injected or erupted rock has brought up some of the

secondary rock, but the actual date of the fissure and its filling up must be comparatively modern in both cases. All these Italian mines differ in a striking and even startling manner from those of Cornwall and other parts of the British Isles. They are quite as different from the copper mines of Germany and Scandinavia. They introduce us to the phenomenon of a great accumulation of copper ores of the ordinary kind (copper pyrites), in veins in comparatively modern volcanic rock, these veins having been formed long after the older tertiary rock had become deposited and hardened. The cretaceous rock, and even the older tertiaries had been in some cases elevated before the formation of the fissures now filled up with lava, and the lava had cooled and solidified and cracked before the copper made its appearance.

The mine of Monte Catini (della cava) is worked in a very peculiar vein of soft magnesian rock (approaching serpentine in its nature, but much softer), occupying a dyke or fissure in the *gabbro*, which is apparently itself an eruptive rock originally forced through, over, and amongst the upper cretaceous limestone of Tuscany, here called *alberese*.* The alberese is a compact pale blue, or greyish blue limestone, hard and penetrated with numerous strings of calc spar. It occupies the hills and neighbouring high ground, but is generally covered with a soft marly rock, often containing gypsum, and sometimes rock salt. The latter mineral is abundant, and is worked in the Saline in the valley of the Cécina adjacent.

The alberese is a cretaceous limestone, and the overlying soft marl are tertiary. It appears to me that there has been an eruption of igneous rock through fissures in the alberese at a time when the tertiary deposit was much more extensive than it now is. Thrust up through this rock, which is locally squeezed, contorted, and broken, and forming a dyke in the soft tertiary clays above, the nearest adjacent clays are converted into shales, which are hard and compact enough where they approach the igneous rock. In certain places the flow of lava has been through two nearly adjacent fissures, meeting one another, and leaving at and near the place of contact large open spaces. In the course of time the softer earth on each side of the vein has been washed away, and there is now left on the flank of the mountain little more than the hardened and altered rock. This forms the nucleus of *gabbro*, which here consists of irregular rounded lumps of hard, compact rock, resembling greenstone embedded in a kind of soft porphyritic mass, weathering rapidly on exposure, and easily removed underground. This gabbro looks much like a true serpentine (pale greenish crystals in a dark green bed), and is evidently highly magnesian.

It is in fissures closed towards the surface, and there presenting nothing but reddish clays, which, however, are easily distinguished from the gabbro, that we find the only indications of the rich lodes, or rather pockets, existing below. It is believed that in former times

* The name *alberese* is given both to the chalky limestones of the upper part of the cretaceous series, and also to the similar rocks of the upper part of the eocene tertiaries. It expresses mineral character. At Monte Catini the *alberese* of the cretaceous period is thrust through the *alberese* of the tertiary period, and they are in contact.

much valuable ore was got from the surface in other portions of the lode, or from pockets intersected at the surface, but of this there now seems no indication. Generally, the narrow cracks with their red clay contain a few small rounded nodules of rich sulphide of copper, often with very little iron. It is these that yield the larger lumps when followed downwards.

The vein, as recognized at present, is very irregular in width and contents. The chief ore has been obtained in isolated pockets at various depths, down to about 120 yards. These are, to all appearance, absolutely irregular. They do not seem to have reference to any peculiar condition of the serpentinous veinstone beyond the presence of red clay. They are not confined to any part of the lode, but range out of it into the gabbro, some of the richest deposits now worked being altogether in the gabbro. Veins pass off, commencing with a thin line of orey serpentine, and running out of the main lode into the gabbro, but gradually enlarging and becoming very rich. The general direction of the lode is east and west, and the dip south, and the richest of these side veins have similar bearings, but dip at a greater angle.

At a depth of about 80 yards the lode is interrupted by a broken mass or dome of alberese and shale, near the contact with which a large quantity of excellent ore was found. Below this again gabbro has been reached. In the main adit, driven for more than a mile to drain the mine to the 30-fathom level, a somewhat similar mass of alberese and shale was crossed. It would seem, therefore, that the fracture of the rock through which the lava was poured occurred at about this point, and thus irregular fragments of rock of considerable size are apparently included. But I noticed that the limestone is only so far altered at this point as to show more than usual of that peculiar interlacing of calc spar, for which it is elsewhere more or less remarkable. The general character and appearance of the rock (a compact pale grey indurated limestone) is accurately preserved close to the gabbro.

Not only is the limestone not altered, but the shales with it are still soft, and even rotten. The serpentinous mass containing the ore is also in the same state. It is only by the extreme crushing and squeezing that the limestone and associated shales have undergone, and by observing that they are bent, and broken, and turned in every direction, that one can realize the fact of the great forces to which they have been subjected.

In all parts of the gabbro and in the serpentinous and steatitic masses of the vein, calc spar, crystallized more or less perfectly, is to be seen. But magnesia is the prevalent mineral. All the rock is more or less steatitic, and presents those peculiar appearances that steatitic minerals so often do. A strong resemblance to slickensides is one of these, and most observers have concluded, from the numerous striæ and polished surfaces which the stone presents, that the whole vein and its contents have been slid over one another, and that the striæ and polished surface are mechanical. This I am inclined to no doubt.

The ore in the serpentinous vein is all in nodules. These vary in size exceedingly, but they vary little in appearance, and all probably have the same origin. They are masses of sulphide of copper and iron, the central part being the hardest and most ferruginous, and the other part containing the richest and purest copper ore. This outer part is often peacock ore, and sometimes grey sulphuret. Earthy carbonate of copper is rare, and malachite, or compact carbonate, quite unknown. Native copper is found, but only in small detached fragments (not crystalline) in the gabbro. No crystals of copper ore have been found—a fact sufficiently remarkable.

The kidney-shaped, rounded nodules of ore are in some parts of the lode accompanied by a considerable quantity of equally rich ore, disseminated through the veinstone, and only separable by dressing. It has sometimes been thought that these rounded masses are water-worn, but this I greatly doubt.

One of the first things that struck me when I visited the Monte Catini mine, and looked at the surrounding country, was the contrast it offered to ordinary mining districts in our own country, and the curious resemblance to what I had seen in Algeria, in the mines of Mouzäia, in the Lesser Atlas. Here rich ores of similar nature have been found distributed in the same irregular manner in bunches communicating by narrow threads. The veins range N.E. and S.W., parallel to the mountain chains, and traverse altered tertiary rock, cretaceous limestone, and shale. The serpentine is there absent, though there are not wanting trachytic porphyries, representing those of Monte Catini. The fact that tertiary rocks are fractured to form veins in both cases, and the mode in which the veins have since been filled up, are not the only points of resemblance.

Another remarkable instance occurs in the celebrated mines of Cobre, in Cuba, where rich and abundant copper ores are found in a district abounding with limestone. The rock containing the vein here consists, however, of a calcareous porphyry, passing into limestone on the one hand, and basalt on the other. The particulars of this curious lode I have described in the 'Proceedings of the Geological Society,' vol. xiii. (1857), p. 240. The general bearing of the lode is east and west, parallel to the coast, and to the principal mountain ridges.

To those accustomed to regard the great system of veins, the principal deposit of ore, and all the important modifications and transformations of rocks and their contents, as events altogether beyond recent geological times, these accounts of very important deposits of copper in modern calcareous rock and lavas of tertiary date, cannot fail to excite astonishment. In many respects the vein of Monte Catini is exceptional, but it is extremely suggestive, for it presents to us an example of recent metamorphic action of the most energetic kind connected with modern volcanic disturbance, so far as upheaval and fracture are concerned, but also indicating the presence and influence of water, by whose agency crevices, once formed by violence, have been subsequently filled up. The steady, permanent, and all-pervading influence of water, producing now the same effects that it has always done, is perhaps nowhere more clearly exemplified than in Central

Italy, where a complicated series of lavas, of various dates, penetrating cretaceous and tertiary rocks, is in turn penetrated by hot vapours and currents of water. These in one place have left behind deposits of copper ore, in another pure sulphur, in another *lagoni* or pools, saturated with salts of borax, while carbonic acid gas, nitrogen, and sulphuretted hydrogen gases issue in abundance.

It is by the help of these gas and water currents, and in the natural course of operations that belong to the ordinary conditions of things, that the mineral veins of Monte Catini and the other mining districts of Tuscany have been filled, and this it is which gives the subject a special interest and value.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The second quarter of 1864 commenced in the agricultural world amidst important sales of home-bred short-horn herds of cattle, and it closes in the midst of important agricultural meetings. These are matters rather of commercial than of scientific interest, and yet they have aspects interesting to the man of science. The enormous prices realized for certain families or strains of blood among pure bred live stock possess an interest apart from that which they present to the crowd of enterprising men who are following in the steps of Lord Spencer, or Lord Ducie, Thomas Bates, Jonas Webb, Colonel Towneley. These who have realized hundreds of pounds for individual bulls and cows—the last, who obtained last March upwards of 7,000*l.* for a herd of 56 animals of all ages—have not only illustrated the enterprise and wealth of English agriculturists, a matter only of commercial importance, but they have proved the power of the breeder to create that fixity of type in his animals, out of which this extraordinary value has arisen; and this is a matter of scientific interest.

It may be illustrated by the history of what is called the "Duchess" tribe of short-horns. More than fifty years ago, when Charles Colling's herd was sold, a young heifer named Duchess was bought by Mr. Thomas Bates, of Kirkleavington. From her was descended this tribe, which are believed to possess all the leading merits of the breed in an extraordinary degree. In particular they are possessed of a remarkably soft and silken touch—abundant hair, and other indications of vigour—most symmetrical form, great and equal width of back, well-arched ribs, and prominence and width of bosom. They possess, in fact, great precocity of growth, and a tendency to grow most and fastest in those parts where the flesh is of the best quality for food. They have the highest reputation also for the certainty with which their bulls hand down these properties to their offspring; and they thus command the very highest prices in the market. This is one of the results of what is called "breeding in and in." Animals that have inherited again and again, in the course of their pedigree, the qualities which relationship in blood has conferred in common, possess those qualities much more energetically than others do in whom they are observed for the first time. A cross-bred ram may have a very desirable coat upon his back, and a very well made carcase of mutton within that coat; but it is exactly a toss-up whether his progeny acquire the character of his sire or of his dam. If sire and dam for generations back, however, have exhibited constancy and uniformity of character, then that character is certain to reappear in their offspring, which, in his or her turn, will possess still greater

power of transmitting good tendencies to the succeeding generation. It is thus that not only in the "Duchess" blood, but in other tribes descended from the Kirkleavington herd, we have as the result of Mr. Bates's resolution, patience, skill, and constancy, qualities which reappear in generation after generation of Kirkleavington families of the short-horn breed, until the animal may now be safely characterized as good if known to be of Bates's blood. Bates's blood, or rather Bates's *brains*—for it is the mental, and in many important particulars, the moral character of the breeder which is reflected now in so many different herds—is merely another word for patient persistence in breeding from animals of a given type, in a great measure disregarding the question of relationship, if they possess the requisite health and vigour of constitution. Of course, when evils of any kind are inherited, such as a tendency to disease or weakness of any kind, breeding in and in will intensify and hand that down with as much certainty as any other quality; but the natural law of breeding which obtains amongst gregarious animals, where the strongest sire is the father of the herd or flock—to the almost entire disregard of previous natural relationship, is a safe one to follow. It is a natural law of this kind that gives to particular herds and flocks, where they have been long under the control of one man, their uniformity of character from year to year. And it is out of the consequent certainty which animals thus bred transmit the qualities they have inherited, that those extraordinary prices are commanded by them, which, while they sometimes startle the commercial world, have thus an interest for the man of science.

The other topic of the period, of chief agricultural interest, is the annual meetings of our great national and provincial Agricultural Societies. On these occasions, the best animals of all our breeds of the domestic animals of the farm, and the best machines known to agriculturists or agricultural engineers, are collected, professedly for the prizes offered by the Society, really for the purpose of that advertisement, publicity, and distinction, which mere exhibition before a multitude, and especially the achievement of any award of merit, under such circumstances confers.

Our national societies with incomes of 10,000*l.* per annum, and the many local and county societies with incomes of one to three thousand pounds each, are among the most striking illustrations we can quote of our agricultural energy and enterprise; for these sums are but a fraction of the expenditure which these annual shows occasion, and give but a faint idea of the commercial advantages which they offer; and the strictly educational results of these meetings in which we are here more particularly interested, can hardly be overrated. Breeders realize their own deficiencies by a comparison with the best animals of the best herds and flocks; and machine makers have both their inventive faculties stimulated and their manufacturing abilities quickened and increased by competition with each other, on the same field close to one another, where the prize of commercial merit is so great. Above all, the agriculturists of a whole province realize the progress which the best examples thus collected for their inspection prove to have been accomplished.

If we except the journals of our agricultural societies by which agricultural progress is brought directly under the notice of readers, these annual shows are the only educational influence which these societies exert. It has only lately been brought under the notice of the Royal Agricultural Society of England that one of the objects for which, according to its charter, it was incorporated, is the promotion of the better education of those who live by the cultivation of the land; and that except indirectly, as by journals and exhibitions, nothing whatever has yet been done by it in discharge of its duty in the matter. A committee of inquiry into the subject is now sitting, which will, we hope, result in some more definite and systematic attempt than has yet been made to bring the great influence and large income of the National Society to bear upon this subject. What seems to be wanted, and what is within the competency and indeed the duty of the Society to effect, is not any such stimulus of general middle class education as our Universities and the Society of Arts are presenting by their annual examinations of students, nor any such guidance and assistance as the Government offers by its Inspectors and endowments of schools; but help, both in guidance and in stimulant, to *professional* agricultural schools, and the establishment of these in greater number than they now exist. The Royal Agricultural College at Cirencester is indeed, we think, the only one of the kind in Great Britain. It is, as we believe, owing to a culpable neglect of the seventh object specified in the Charter of the Royal Agricultural Society of England, as among the purposes of its incorporation, that that institution is not in a more flourishing condition than it now presents, and also that many of similar character have not been established in our principal agricultural counties.

There is an able review of recent agricultural progress drawn up by Mr. Thompson, M.P., in the current number of the 'Journal of the Agricultural Society.' It proves that the importation of guano and of bones, the manure manufacture, the more general application of steam-power in agriculture, and the influence of the National Agricultural Society, have together added greatly to the fertility of English soil. There is, however, a singular exception to this increased produce, which needs to be more urgently pointed out to agriculturists than it has yet been. The quantity of mutton sent to market appears to be hardly more now than fifteen or twenty years ago. The number of sheep and carcases sent to the London market does not appear to have materially increased during that time. With wool at the extraordinary price which it has of late commanded—2*s.* to 2*s.* 6*d.* per lb.—mutton at a price unknown ten or fifteen years ago, and a climate which over most of the island has all along impressed observers with the idea that succulent and grass growth, sheep food in fact, is a much more natural produce of our soil than seeds and grain and ripened produce, it seems impossible to doubt that our flocks and herds must multiply, and our farm management be more immediately directed to this end than it has been.

It does not necessarily follow from this that our grain produce would be diminished. The increased manure derived from the con-

sumption of increased cattle food tends to the increased fertility of our arable lands, and in this way corrects the effect which would follow the apportionment of more acres to the growth of grass and green crops; and it is quite possible largely to increase the growth of green food without diminishing our extent of green crops. Nowhere does liberal management more certainly produce a greater growth than in the case of grass.

Italian rye grass in particular seems to yield a crop which is limited only by the quantity of manure applied, and it is through this crop, doubtless, that the sewage of our towns will yet yield to that "cleanly manipulation," which is to convert it into milk. This subject is again brought under public notice by the appointment of a Committee of the House Commons, to inquire into the engineering difficulties in its way. What the result will be when these are overcome, and the liquid refuse of our towns is spread over fields of grass at some distance from the population, is plain from the instances of Edinburgh, Rugby, and Croydon. Near the latter town we walked the other day over Mr. Marriage's farm of 300 acres, almost wholly under sewage and Italian rye grass, where 30 to 40 tons of grass per acre are mown annually, and sold at 12*s.* to 15*s.* a ton on the ground, and 20*s.* to 23*s.* a ton in London.

On these particular departments of the agricultural field, and especially on the great question of the national food supply, in which they all unite and culminate, there is great lack of trustworthy information, and it must be stated with satisfaction, as strictly within the scope of a scientific record, that an additional attempt has just been made by Mr. Caird, M.P., to urge on Government the duty of collecting the agricultural statistics of the country.

"The need of authoritative (because accurate) published intelligence regarding the extent and prospects of our several food crops, in the interests of consumers and producers no less than in that of commerce generally, is becoming more and more admitted. The county police, the relieving-officers, and the tax-collectors, have all been suggested as the agency by which the information sought might be most easily obtained. Mr. Caird now suggests, as a new agency, the engineers employed upon the Ordnance Survey. He proposes not that the whole country should be mapped out and allotted, but that certain characteristic plots, typical of the larger districts of similar soil and climate, should be selected. He supposes that Great Britain might be divided into 15 districts, and that 100,000 acres in each district might be taken as characteristic of it. These 100,000 acres would be laid down on the Ordnance Map, and subjected to an exhaustive inquiry. And the 1,500,000 acres thus investigated being about one-tenth of the cultivated land of Great Britain, would furnish the acreage and yield of their several crops, which, multiplied by ten, would supply us with trustworthy information of the gross agricultural produce of the country.

"Mr. Caird points out that there have been three objections hitherto urged to the collection of agricultural statistics:—

"I. The cost.

"II. The inquisitorial character of the inquiry.

"III. The difficulty of obtaining accurate returns.

"1. By the plan now to be submitted, the cost is not expected to exceed 3,000*l.* a year—an amount which, compared with the object, is not worth a moment's consideration.

"2. Neither the names nor the boundaries of individual farms will be known, and neither the persons making the inquiry, nor those to whom the results are communicated, can tell the precise farms to which the returns refer. The complaint of inquisitorial inquiry cannot, therefore, arise.

"3. The typical districts will be fixed quantities—say 100,000 acres each—laid down on the Ordnance Maps. Every acre within that limit will be exhausted, so that absolute accuracy will be attained.

"We believe that the more this subject is considered and discussed by intelligent agriculturists, the readier will they be to admit the advantage which the agricultural, as well as the commercial interests of the country, must derive from the information which the prosecution of Mr. Caird's plan must furnish."

Meanwhile it is satisfactory to know that a resolution affirming the importance and need of a national inquiry into the subject was the other day carried in the House by Mr. Caird.

The last subject to which we refer in our Agricultural Chronicle of the past quarter is the condition of rural cottages. Under the general question of the dwelling of the labouring class, this was lately made the subject of a conference before the Society of Arts, when a number of influential men united to consult on a remedy for the glaring evils which imperfect house accommodation inflicts. It was resolved, that much of the existing mischief is due to the Law of Settlement and the limited area of the Poor Law rating; that the tenure of property and the legal difficulties in obtaining sites are much in the way; but that—

"By proper attention to economy, by building to the extent only required by each district, and by the utmost care in avoiding unnecessary outlay in preliminary expenses, proper dwellings for the labouring classes can be provided which will realize in towns a fair dividend on the capital expended; and that although in rural districts, commonly speaking, the pecuniary return for capital invested in labourers' dwellings, considering the rate of their wages and their general circumstances, and the cost of repairs, can only be moderate, yet it may be regarded as satisfactory, when the consequent improvement of the character of the occupants, their comfort, their health, and the additional value of their labour are taken into account."

The chairman of the conference urged that, in the various Land Improvement Acts and in the Government Drainage Acts, there is ample precedent for Government loans, at a low rate of interest, for the express purpose of cottage improvement. And Mr. Akroyd, of Halifax, described the way in which, with the aid of building societies, no less a sum than 1,200,000*l.* had been spent in three towns of the West Riding, chiefly by the working men themselves, in the erection of good cottages, now or fast becoming the property of their tenants.

In agricultural districts where low wages interfere with the possibility of the labourer thus helping himself, there are especial facilities in the way of the landlord.

"The difference between the field and the garden-value of land is, in fact, the cottage-building landlord's great resource and help. Ten acres of land divided into large gardens for a hamlet of 20 or two-dozen new cottages may be worth but 15*l.* per annum to the farmers; they are, however, worth from 60*l.* to 80*l.* per annum to the tenants of the cottages. And the difference between those two sums represents a capital sum of 900*l.* to 1,300*l.*, which is a contribution of 30*l.* to 40*l.* per cottage towards the cost of their erection. Add to this the interest of the tenant-farmer in having labourers near their work, which should make him willing to bear his share of the annual cost of cottages upon the farm; and it appears to us that in country districts there is little real difficulty in the way of those owners of land who may lament the insufficiency of cottage accommodation on their land.

"The man-engine in the Cornish mine, by which half-an-hour suffices to take the miner to and from his work, in place of the hour or two at either end of the day wasted in climbing up and down the ladders, has added a full third to the efficiency of his labour. A cottage on the farm compared with one in the village three miles off, is like a man-engine in contrast with the ladders. A labourer fresh to his task can accomplish it more satisfactorily than one who does an hour's work before beginning it. And the tenant-farmer on this ground may well be expected to bear his share in the burden of supplying the cottages by which the value of his labourers is so much increased to him, and the profitableness of his farm is increased."

The plan adopted at Dumbleton by Mr. Holland, M.P., takes account of both of these considerations. A rent of 6*l.* pays a sufficient interest for the capital invested in the cottage. Of this, the cottager pays 3*l.* for the house and 1*l.* for the large garden; the farmer pays 1*l.* in consideration of the increased value of the man's labour; and the landlord pays 1*l.*, or rather cancels 1*l.*, because of the increased value which the estate possesses, or will possess, in the existence of a well-conditioned labouring population.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

The progress of Astronomy during the past few months has not been characterized by such marked advances as those which will make the previous session long memorable in the annals of this science.

In Sidereal astronomy, while Krüger had found measurable parallaxes for two or three additional stars, the unwearied Goldschmidt was successfully engaged on the system of *Sirius*, and had been rewarded with the discovery of some other minute companions. In the solar system the advances in our knowledge were still more important. The necessity for a considerable augmentation of the sun's parallax had been established by so many different investigations, that it scarcely admits of further controversy, and there is little doubt that the correct value is now known within a very few hundredths of a second. The distance of Mars had been measured and delineated at

the last opposition with an accuracy never before attempted. Mr. De la Rue, far from being content with the admirable results which he had obtained in celestial photography, had made additional and successful efforts for its further improvement. And, finally, the surface of the sun had been the subject of study to various astronomers, best fitted by their intelligence, their sharp-sightedness, and their command of appropriate apparatus, to extend our knowledge of this marvellous body. Nor are the different Observatories, both public and private, to be passed over in this brief review. At Greenwich the great Equatorial was employed during the past year in observations of the fixed lines of the stellar spectra, and recently the prism apparatus has been provisionally altered, so that, instead of producing astigmatic breadth of the spectrum by the unequal refractions of a conical pencil at the two sides of the prism, a pencil of rays made parallel by a lens traverses the prism, and, after being made convergent by a second lens, is made astigmatic by a cylindrical lens. The definition of lines appears to be improved, and the facility of measuring them increased. The same equatorial has also been used in observations of the Nebula of *Orion*, with results which show that the older drawing printed by Sir J. Herschel in the *Results of the Cape Observations*, 1847, is a more accurate representation of the appearance now presented by the Nebula, than the more recent drawing by Professor G. P. Bond. It is the opinion of the observers that Sir John Herschel's drawing represents as accurately as perhaps any drawing can, the appearances presented about the so-called jaws. According to this, there appears to be no valid reason for the supposition that the Nebula of Orion has been slowly altering its character of late years. At the Royal Observatory, Edinburgh, where time-signalling is one of the specialities, some important extensions have been made, and there were at the beginning of this session no less than seven separate time-gun signals fired in different cities in England and Scotland directly from the Royal Observatory, Edinburgh, whilst five more cities were in pretty active preparation. For short lines the system of explosion, based on the use of Professor Wheatstone's magneto-exploder and Mr. Abel's fuse, was found to answer perfectly, and it was also frequently successful between Edinburgh and Newcastle, a distance of 120 miles; but when the insulation was bad, by reason of fogs, the high intensity of the magnetic currents caused their loss and dissipation before reaching their destination. Hence a system was devised by which a current of electricity of low intensity was despatched along the line; and this, on reaching the town where the time-gun was placed, automatically liberated a current of magneto-electricity, which then passed along a covered wire for the short distance up to the time-gun. In the twelfth volume of printed Astronomical Observations lately issued from this Observatory, an addition of an unusual character is worthy of notice, namely, four plates photographic and one photoglyphic; the latter especially prepared for the occasion by Mr. Fox Talbot, the inventor both of photography and photoglyphy. The scientific reason for the introduction of these plates, which are highly magnified portions of some of the Teneriffe photographs of

1856, is the remarkable testimony which they bear to the transparency of the atmosphere, and its suitability to telescopic observation at great heights above the sea level. At the Radcliffe Observatory Mr. Main has been rigorously continuing observations of double stars with the heliometer. Most of these stars had been previously examined by Struve, the components being of nearly equal magnitudes, varying from about the sixth to the ninth; and Struve concluded that there was very great probability that the larger number, if not the whole of them, were *physically* and not *optically* connected. The results of the Oxford observations, thus far, do not confirm this idea, as in the interval of more than thirty years which have elapsed since Struve's observations, out of 190 systems examined, very few of the components exhibit any considerable motions in distance or position angle. At Cambridge, the regular work of an Observatory has been assiduously performed, and time has also been found for the ever-varying observations which special or seldom recurring phenomena demand, such as cometary observations, &c.; although from the absence of a first assistant, Professor Adams feels that the work of the Observatory during the past year has been seriously crippled. At the Liverpool Observatory, owing to local considerations, meteorology very properly claims the chief attention. Their new and most ingenious self-registering barometer has been in operation for about twelve months; the sheets on which the record is obtained are removed from the cylinder every morning at 9 A.M., and a tracing from the original, for the previous 24 hours, is forwarded daily at 10 A.M. to the Underwriters' Rooms, together with an account of the force and direction of the wind, the fall of rain, &c. The rating of ships' chronometers, always an important branch of the work of a sea-port Observatory, has here largely increased during the last year, and considerable alterations have been made in the method of giving the errors and rates. During the winter months each chronometer is exposed for a week to the temperature 50°, 65°, and 80°, alternately; and for whatever time the chronometer may be at the Observatory, the error is given at the end of each seven days, together with the mean rate and extreme difference of rate between any two days for each week. The latter, Mr. Hartnup thinks, shows the quality of a chronometer better than any other method he has been able to devise. At Mr. De la Rue's Observatory, Cranford, devoted almost exclusively to astronomical photography, observations have been made with silvered glass mirrors, as a less expensive and more reflective substitute for the speculum metal mirrors, and there is every reason to believe that the time of exposure of the sensitive plate will, by this means, be shortened. Mr. De la Rue has continued his experiments in enlarging his lunar negative to the dimensions of Beer and Mädler's map (38 inches), and has obtained results far surpassing those previously recorded. The Ely and Kew Observatories have been, during the past year, principally devoted to solar photography; a large number of solar autographs have been taken, and, by a comparison of the pictures taken simultaneously at each Observatory, it is anticipated that much information will be gained on the obscure

subject of solar spots. At Ely, a large refractor of 6 inches aperture has been got into working order, and we may soon expect to hear that Mr. Titterton has succeeded in obtaining, by its means, solar autographs of 6 inches diameter.

The discussion on the phenomena in the solar envelopes, commenced by Mr. Nasmyth, is still occupying great attention. A question has arisen whether the general appearance of the photosphere is that of a flocculent precipitate, as suggested by Sir John Herschel, and assented to by Dr. Dawes, or whether it more nearly resembles a willow-leaved crystalline precipitate of detached particles, as originally described by Mr. Nasmyth and confirmed by Mr. De la Rue and Mr. Pritchard; and more lately Mr. Stone, with the large Greenwich refractor, has confirmed the existence of these strange entities, which to him appear like grains of rice. Although individual observers may therefore differ among themselves as to the exact shape of these particles, there appears to be no doubt that the sun's photosphere is covered with solid bodies, the immediate origin of the solar light, somewhat uniform in size and shape, the smallest of them having an area exceeding that of the British Isles!

Magnus* has lately recorded an experiment which, whilst it supports the lately propounded theory of Kirchhoff, on the constitution of the sun, in a striking manner, also appears to be quite concordant with the "willow-leaf" discoveries. It is well known that when a non-luminous gas-flame has a sodium compound introduced into it, the whole flame becomes brilliantly luminous with yellow light. Similarly, if lithium, strontium, or other metallic compounds are introduced into the flame, brilliant light of other colours is evolved. Now, Magnus has shown that the radiation of *heat* is also increased when these metallic vapours are rendered incandescent in the flame. The experiment was so arranged that a fixed spot in the soda flame was always compared with the same spot in the non-luminous flame, and care was also taken that the heat from the solid soda introduced into the flame, or from the platinum-wire which held it, could not radiate against the thermo-pile which served for the observation. The luminous flame radiated about a third more heat than when it was non-luminous. When, instead of soda vapour, a solid body, such as platinum, was brought into the portion of the flame experimented upon, a still greater radiation of heat occurred, and when the plate was covered with carbonate of soda the radiation increased afresh, and by keeping the flame likewise luminous with soda vapour the radiation of heat was increased three-fold. These experiments show that gaseous bodies radiate very much less heat than solids or liquids; it can therefore hardly be maintained that a gaseous or vaporous photosphere is the seat of the solar heat. The luminous- and heat-radiating particles in the yellow gas flame are therefore probably single torn-off particles of solid (or liquid) matter incandescent in the flame, and, comparing great things with small, they may be regarded as the counterparts of the willow-leaf particles in the solar envelope.

* 'Poggendorff's Annalen,' No. 3, 1864; and 'Phil. Mag.,' May, 1864.

Furthermore, it was shown * some years ago that, by holding one soda flame in front of another, the outer envelope of the front flame acted as an opaque screen to the brilliant yellow light radiating from the flame behind it; and that if this opaque part of the flame were introduced into the path of the light in a spectroscope, it would carve out of the most luminous portion Fraünhofer's double black line **D**. Furthermore, if other metallic particles were allowed to colour the flame (*e.g.* lithium, thallium, &c.) they would likewise act as opaque screens to rays of light of their own refrangibility, and would produce black lines, the exact counterparts of Fraünhofer's lines, in the solar spectrum. Now the portion of the flame possessing this great absorptive power is, upon examination, found to be a very faintly luminous exterior envelope, quite outside the luminous portion of the flame. Applying these facts to our theory of the solar envelopes, they fall into their places very naturally. The willow-leaves are the representatives of the atoms of incandescent metallic particles existing in our gas flame, whilst the highly-absorbent non-luminous outer envelope of the flame will represent the envelope of vapour which, on the sun's surface, is the cause of the phenomena of Fraünhofer's lines.

At one of the recent meetings of the Literary and Philosophical Society of Manchester, Mr. Baxendell brought forward an hypothesis, based upon an investigation of magnetical and meteorological phenomena, which confirms, in an unexpected manner, one of the most recent conclusions in theoretical astronomy. The results of the elaborate investigations of the motions of the planet Mercury, made by M. Leverrier, led that mathematician to attribute a certain unexplained excess in the motion of its perihelion to the action of a disturbing body circulating round the sun within the orbit of Mercury; and from a discussion of the probable mass of the disturbing body, he concluded that it could not be concentrated in a single planet, but that it consisted of a ring of small bodies, similar to that which is known to exist between the orbits of Mars and Jupiter. This ring, however, owing to its proximity to the Sun, may never be seen, and like the dark companions of Procyon and Sirius, it may only be known to us through its action on the other bodies of the system, of which it forms a part. An elaborate discussion of meteorological and magnetic phenomena has now led Mr. Baxendell to the suppositions—

1. That a ring of nebulous matter circulates round the sun in a plane nearly coincident with that of the ecliptic—the density of this ring differing in different parts.

2. That the attractive force of the sun on the ring varies inversely as the solar spots, being greatest when these are fewest, and least when the spots are most numerous.

3. The attractive force being variable, the dimensions of the ring and its period of revolution round the sun will also vary, their maxima and minima occurring respectively at the times of maximum

* "Crookes on the Opacity of the Soda Flame to Light of its own Colour." 'Chemical News,' vol. iii. p. 2.

and minimum solar spot frequency. By means of these hypotheses, our author explains many of the phenomena of the solar spots, the magnetic variations, the alterations of terrestrial temperature, and the changes in the direction of the wind. He has calculated that the greatest and least values of the sidereal period of revolution of the ring will be 29·12 and 22·08 days respectively. From these numbers we find that the greatest distance of the ring from the sun is 0·185, the radius of the earth's orbit being taken as unity; the least distance 0·154, and the mean 0·169. Taking Mr. Hind's value of the mean distance of the earth from the sun, namely, 91,328,600 miles, we have—

Greatest distance of the ring	=	16,921,000	miles;
Least " "	=	14,068,000	"
Mean " "	=	15,494,500	"

and the range of movement to and fro, in a radial direction, =2,853,000 miles. The greatest attractive force of the sun on the ring being taken as unity, the least will be 0·691. Should future researches place the existence of this ring beyond doubt, this will, it is believed, be the first instance in which the conclusions of physical astronomy have been confirmed by the results of an investigation of magnetical and meteorological phenomena.

M. Faye * has given an account of a new method proposed by M. De Littrow, for determining the time and the longitude at sea. The method consists in the determination of the time by two circummeridional observations of the sun, preserving at the same time the observation of the true noon for the latitude. The two altitudes may be taken at pleasure, on the same side, or on opposite sides of the meridian; the interval of time is arbitrary, varying according to the circumstances, from 5 to 30 or 40 minutes; and as the calculation takes only five minutes, the navigator may in half-an-hour take his observations, and effect all the calculations necessary for finding at once the longitude and the latitude. The new process depends on the fact that when, as at sea, a scrupulous accuracy is not required, the circummeridional altitudes of the sun may be used for determining the time. The method was tried on the voyage of circumnavigation of the Austrian frigate, the 'Novara,' and the results were generally correct, within a probable error of one or two nautical miles. This method might be equally useful on *terra firmâ* as at sea; for travellers, as well as for sailors, it would be useful to have a convenient method of determining daily their latitude and longitude, by observations concentrated at a single epoch of the day—about noon.

The Royal Astronomical Society.

In the 'Proceedings of the Royal Astronomical Society,' for March, Mr. Dunkin has given an interesting note on the number of luminous particles contained within a confined space on the sun's disc. The power used was about 100, and a system of wires in the

* 'Comptes Rendus,' March 7, 1864.

eye-piece of the telescope divided the centre of the field into nearly square spaces, the angular distance between the wires being 56″ in a vertical direction, and 48″ in a horizontal direction. The number of particles enclosed at one time within these spaces was estimated to be about 300, say about twenty in one direction, and fifteen in the other, and scattered equally about. As a deduction from these observations, Mr. Dunkin considers that the average length of these particles is about 2″, though there are some larger and many smaller. This observation was made on March 10th, but on repeating the examination on March 16th, the luminous particles appeared more thinly scattered, the number estimated to be contained in the nearly square spaces being about 200

At the April meeting of the Royal Astronomical Society, the willow-leaved structure of the sun's photosphere was again brought forward, the Rev. W. R. Dawes affirming that the most recent observations had merely landed the different observers where he was sixteen years ago. In the beginning of the year 1848 Mr. Dawes, upon examining the disc of the sun by means of a transparent diagonal on Sir John Herschel's principle (power 65, aperture $6\frac{1}{3}$ in.), observed bright particles scattered almost all over the sun, which he then compared with two excessively minute fragments of porcelain. Four years afterwards, assisted by his new solar eye-piece, Mr. Dawes arrived at the conviction that these brilliant objects were not distinct entities, but were merely different conditions of the surface of the comparatively large luminous clouds themselves—ridges, waves, hills, distinguishable brightnesses—parts of the same luminous clouds which happen to be brighter than the other parts. These statements gave rise to an animated discussion. Mr. Pritchard suggested that Mr. Dawes might possibly have been impeded in the correctness of his observations, owing to the very minute aperture of his solar eye-piece; diffraction being likely to come into play to an inconvenient extent. Mr. Huggins thought that when a high magnifying power was used, the rice, or willow-leaved particles lost the uniform appearance which they have with a low power. At the same meeting a communication from Mr. Nasmyth was read, in which he gives four different forms of objects as he observed them. First, he draws the willow-leaves, No. 1; No. 2 is shorter, and a little wider; No. 3 is shorter still, and a little wider still; and No. 4 is exactly of the rice-grain pattern. No. 1 is the type of those forming the details of the penumbral strata; No. 2 is that which forms the details of bridges; No. 3 is the form which constitutes the other parts of the bridges in the margin of the photosphere. Both 3 and 4 may be said to be a type of those that may be seen over the entire surface of the photosphere.

Returning from the subject of willow-leaves to the other astronomical advancements during the past few months, we must not omit to mention the list of new double stars discovered by the Rev. W. R. Dawes. He gives a list of fifteen, and accompanies them by designation, full measurements, and remarks. Some, perhaps most of these, are only optically double, yet the example of that highly interesting binary couple, *δ Cygni*, may encourage the hope that other

similar instances may be discovered. Mr. Dawes' No. 1 (p. xx. 177) was discovered in 1840, and occasional examination up to the present time has failed to show any perceptible change either in angle or distance. There would, therefore, appear to be no physical connection between the two, although, from the fact of one of its components having been examined by Struve, at Dorpat, and again by Maedler, without any notice of its being double, it seems almost necessary to conclude that it must have come out rapidly between 1832 and 1840. No. 5, γ *Orionis*, is undoubtedly binary; it was regarded by Struve as single in 1826, and the distance has certainly increased during the last ten years, while the angles remain very nearly stationary. No. 8, L 2362, is an easy double star, but having been overlooked at Dorpat, and again at Poulkova, there is great probability of its turning out to be binary.

The recently discovered companion of Sirius has attracted some attention, both from the Rev. W. R. Dawes and from Mr. Lassell. The former observer has obtained distinct views of this object on two occasions, and obtained a measure of position with the parallel thick wires of the filar micrometer $= 84°{\cdot}86$. The distance measure was estimated to be about 10″. Mr. Lassell has given five position measures, and six distance measures, each being the mean of six, the mean result being, position $= 79°{\cdot}55$, distance $= 10''{\cdot}12$.

Mr. Dunkin has made some remarks urging upon travellers to record, in their determinations of latitudes and longitudes by the sextant, not only the astronomical part of the observations of meridian altitudes, local time, or lunar distances, but the readings of the barometer and thermometer, at least once during each series of observations. The effect of this omission being to render it impossible to deduct the proper correction for refraction in computing the geographical position of the place. As an illustration, he gives the longitude of Kazé, computed from Captain Speke's sextant observations on Feb. 28, 1861. When corrected for refraction and parallax the longitude was 33° 1′ 0″ E.; and when uncorrected, 33° 17′ 0″—making a difference of 16′ 0″.

Two early observations of Uranus, by Bradley, which were brought, by Mr. Breen, before the March meeting of the Astronomical Society, are interesting. The first was on October 21, 1748, when it was observed as a star of the sixth magnitude, by the transit instrument; and the second on September 13, 1750, by the quadrant. The right ascensions are very accurate.

Some observations of comet VI., 1863, which was discovered by Professor Respighi, have led Dr. Weisse to remark that its path closely resembles that of 1810, giving a period of $53\frac{1}{2}$ years, in which case, reckoning back six revolutions, it would probably be identical with the comet of 1490, their paths having some resemblance. But Dr. Michez gives a set of elements, from several observations, in January and February last, which are better satisfied by an elliptic orbit, with a period of about $108\frac{3}{4}$ years. The identity of the comet with that of 1810 is thus doubtful.

A set of elements for the minor planet (79) Eurynome, has been

calculated by Mr. W. A. Royers, from the Washington observations. They are fully given in the 'Monthly Notices, R. A. S.,' vol. xxiv. p. 126.

From some calculations communicated by Herr Theodor Oppelzer to the Astronomer-Royal, and published in the 'Monthly Notices' of the R. A. S., for April of this year, it appears that the identity of D'Arrest's and Pogson's planets can no longer be doubted. From the observations taken at Copenhagen, Berlin, and by Pogson himself, Herr Oppelzer has calculated a small Ephemeris. Astronomers will therefore, in future, regard (76) *Freia* = (80) *Sappho*.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

M. Gris has made recently some experiments on the contents of the vessels of plants. He uses a liquid called the liquor of Fehling, which is usually employed for the detection of glucose. It consists of sulphate of copper, soda-lee (solution of caustic soda), tartrate of soda and potassa, and water, in definite proportions, and it preserves its limpid character when in a state of ebullition. When you add to it in a boiling state a very small quantity of glucose, there is produced a red precipitate of oxide of copper, which, when examined under the microscope, is seen to consist of very minute particles coloured deep brown or almost black. If in place of glucose some drops of sap are allowed to fall into the liquid, you obtain the same red precipitate of oxide of copper. If you immerse in the liquid for some time thick pieces of the wood of the Chestnut, Beech, Poplar, or Cytisus, in early spring, and cut thin slices for microscopical examination, you will notice an abundant precipitate of oxide of copper covering the inner surfaces of the large vessels, so that their course in the thickness of the woody layers may be traced by visible reddish thread-like streaks. As the same precipitate is very abundant in the cells of the medullary rays, M. Gris concludes that the vessels called lymphatic, contain (in spring at least) a sap analogous or identical with that found in the cellular elements of the same branch, and that the precipitate of the oxide of copper is probably determined in both by the presence of glucose. M. Gris thinks that the lymphatic vessels always contain liquid sap mixed with a more or less considerable portion of air.

M. P. Dalimier has performed a series of experiments from which he concludes that the vessels in the course of formation in the young tissues of plants may conduct the sap, but when they are completely formed,—the epoch at which they receive the names of porous or spiral vessels, &c., their normal condition is to contain air; they only contain sap in certain plants, and during a comparatively short time.

M. Belhomme has made experiments on the pollen of plants belonging to the Natural Orders Liliaceæ, Musaceæ, Araceæ, Amaryllis-

daceæ, Boraginaceæ, Solanaceæ, Malvaceæ, Cruciferæ, Passifloraceæ, Cactaceæ, Umbelliferæ, Myrtaceæ, Rosaceæ, and Leguminosæ; and he finds that in Dicotyledons the grains may preserve their fecundating property, under certain conditions, for a period varying from one to three years; whilst, in Monocotyledons, the period extends to six years.

The parasite called Cuscuta cassythoides grows at the Cape of Good Hope, on a species of Lycium, probably L. Afrum. It sends out long line-like branches, which entwine themselves firmly round those of the Lycium, and after one has established itself on a new branch, the connecting link between it and the old stock dies away, and a new plant is established on its own account.

M. Deherain finds that sulphate of lime, when introduced into arable land, does not assist the formation of nitrates or of ammonia, but that it acts by favouring the solubility of potash. According to him it transforms the neutral carbonate of potash into the bicarbonate which filters easily through the arable land. He gives detailed experiments and results in the 'Annales des Sciences Naturelles.'

In a paper on the variability of the Pear, by M. Decaïsne, given in the 'Annales des Sciences Naturelles,' the author maintains that there is no evidence of the degeneration of our fruit trees, in consequence of their continual propagation by grafting. The facts stated by those who contend for degeneration may be explained in various ways, such as climates or soils unsuited for the particular wants of the varieties, bad culture, or improper grafting. Our ancient pears, so justly esteemed for a century or two, are still the same as they were at first. The Crassane, Saint Germain, Doyenné, Chaumontel, Bon-Chrétien, &c., have lost none of their qualities. If they are neglected, it is only because cultivators are looking after novelties. M. Decaïsne also maintains that it is not true that the seeds of good varieties of fruit when sown in ordinary soil have a tendency to go back to a wild state, and produce crab-fruit. He says that no example has been produced of a good fruit fertilized by the pollen of its own flower or of other flowers of the same race, having produced seeds which gave origin to a wild plant with crab fruit. An esteemed variety fertilized by pollen from a variety with sour fruit may no doubt produce fruit of inferior quality; but every good variety, if it is only fertilized by itself, will produce good fruit. He says that we do not find the Canteloup melon returning, by being sown, to the small wild melon of India; nor our cauliflowers and cabbages taking on the form of the wild plants of the sea-shore. Species in the vegetable kingdom are endowed with great flexibility, the same specific type giving rise to races and varieties of very different aspects, but having the same morphological organization, and capable of uniting with each other by crossing, like the members of the same family. If we transport one of our races of pear to all quarters of the globe, we shall find that wherever it can live, it will have a tendency to put itself into harmony with the circumstances in which it is placed, and in course of time it will give origin to numerous new varieties.

Dr. Asa Gray, in the Proceedings of the Academy of Natural Sciences of Philadelphia, gives a synopsis of the genus *Hosackia;* and describes twenty-eight species, almost all of which occur in California. The genus belongs to the Natural Order Leguminosæ, and the tribe Trifolieæ.

Dr. Asa Gray is satisfied that the two genera, Astragalus and Phaca, must be united, and that the genus Phaca must be merged in Astragalus. It is in the Botany of America that the distinction between Phaca and Astragalus is most pressing, and where the data for the answer are most largely to be found. While extra-tropical Asia is the focus of true Astragalus, that of Phaca is in America, mainly in North America, with an extension along the Andes into South America. While the Flora of the Russian Empire enumerates 168 species of Astragalus (of which more than nine-tenths are bilocellate or nearly so), and only six species of Phaca, Dr. Gray recognizes 66 species of the Phaca series, and 52 of Astragalus proper in America. Moreover, rather less than half of the latter are completely bilocellate by a dorsal septum, and at least half-a-dozen different groups have been or might be referred to Phaca. Dr. Asa Gray concludes that Phaca must be merged in Astragalus; and that since in perhaps the majority of Phacæ, there is no intrusion nor peculiar tumidity of the seminiferous suture, the subtribe Astragaleæ of De Candolle has no valid foundation, so that Astragalus is merely a genus of the Galegeæ. The question is also considered by Dr. Gray, whether Oxytropis should be kept a distinct genus. It is characterized by having along with the legume of Phaca, *i. e.* with the ventral suture septiferous, a beak-like acumination or cusp at the apex of the carina of the corolla, whence the generic name. Gray thinks that Oxytropis may still be kept up as a genus on the ground of general convenience, although the pointed keel has been detected in at least one species of true Astragalus (A. Nothoxys). He gives a complete revision and arrangement (mainly by the fruit) of the North American species of Astragalus or Oxytropis in a paper read to the American Academy of Arts and Sciences.

Hermann Hoffman, Professor of Botany at Giessen, has published a very useful 'Index Fungorum.' The names of all known Fungi and synonyms are given, with references to the works in which the plants are described.

From a paper by A. J. Malmoren, translated in Seemann's 'Journal of Botany,' it appears that the Phanerogamic Flora of Spitzbergen contains 95 species of plants.

Dr. F. W. Lewis, in the Proceedings of the Academy of Sciences of Philadelphia, has described some new species of Diatomaceæ. The gathering was made on the margin of a shallow pond, situated in the Notch Valley (White Mountains), from the southern end of which the river Saco takes its rise. The pond is about 200 feet long, and it is supplied by springs welling up from beneath the alluvial detritus forming the pond bottom, which overlies a stratum of clay, beneath

which is the boulder drift. It is in the fine and soft mud, at from 1 to 4 inches below the surface, beneath and immediately around the waters of the pond, that the siliceous remains of the new species are most abundant. The gathering is principally remarkable for two points:—1. The striking analogy which exists between its species and those of the sub-peat deposits of the northern section of the United States. 2. The occurrence of several forms belonging to a known genus *Surirella*, so peculiar and variable in their characters as almost to merit the title of transitionary, by which is meant that these forms may be regarded as just such aberrant varieties of that genus, as we might expect to find conducting to the genera *Nitzschia* and *Synedra*, which in America seem to have followed the genus *Surirella*, at a long interval of time. They exhibit, moreover, such very unusual variation as to size, configuration, and definition of distinctive characters,—such want of generic fixity—as might be supposed likely to mark the incoming of new genera. Dr. Lewis describes the following new species:—*Surirella Baileyi*, *S. intermedia*, and *var. β S. anceps*, *S. delicatissima*, *Actinella punctata*, *Tryblionella* or *Denticula*, *n. sp.*, *Amphora intermedia*, *Navicula*, *n. sp.*, *Mastogloia elegans*, *Amphiprora pulchra*, *var. β*, which seems to be *A. conspicua* of Greville.

Principal Dawson has examined the Flora of the Devonian period, of North-east America, and he comes to the following conclusions:—

1. In its general character the Devonian Flora resembles that of the carboniferous epoch in the prevalence of Gymnosperms and Cryptogams; and, with few exceptions, the generic types of the two periods are the same.

2. Some species which appear early in the Devonian period continue to its close without entering the carboniferous; and the greater majority of the species even of the upper Devonian, do not reappear in the carboniferous period, but a few species extend from the upper Devonian to the lower carboniferous, and thus establish a real passage from the earlier to the later Flora.

3. A large part of the difference between the Devonian and carboniferous Floras is probably due to different geographical conditions. The wide, swampy flats of the coal period do not seem to have existed in the Devonian era. The land was probably less extensive, and more of an upland character. On the other hand, we find that the beds of the Middle Devonian, similar to the underclays of the coal measures, are filled, not with *Stigmaria*, but with rhizomes of *Psilophyton*.

4. The conditions in the Devonian period seem to have been less favourable to the preservation of plants than those of the coal epoch.

5. The Devonian Flora was not of a lower grade than that of the coal period.

6. The general character of the Devonian Flora, in America, is very similar to that of the same period in Europe. Yet the number of identical species does not seem to be so great as in the coal-fields of the two continents.

In a paper on the coal formation of North America, given in the

American 'Journal of Science and Arts,' M. Leo Lesquereux makes some important remarks in regard to fossil ferns. He says that the family of ferns was represented at the coal epoch by species which are easily referred to a very few typical forms. If we consider the figure of the leaves, *i.e.* their contour and venation, the only part generally preserved in the shales of the coal measure, all the species may be comprised in the three sections—Neuropterideæ, Pecopterideæ, and Sphenopterideæ. From the scarcity of fructified specimens of fossil ferns in the coal measures, it might be supposed that most of the species were without fruit. The want of fructification is rather casual than real. By careful examination at some places, where the remains of a species are found in abundance, one may generally succeed in finding traces of fructification. The sporangia seem in most cases to have disappeared, from long and continued immersion in water. Moreover, the fern fronds have usually the lower surface attached to the shale in such a way that the fructification cannot be observed. We can sometimes observe an indistinct outline of the form of the sporangia printed in relief through the carbonized tissue of the fronds. The scarcity of large stems would seem to lead to the conclusion that during the formation of coal, tree-ferns were of rare occurrence, at least when compared with the great number of ferns. If we consider as remains of true arborescent ferns, only those whose outer surface is marked by large oval cicatrices, and known under the names of *Caulopteris* and *Protopteris*, it is certain that they are very scarce in the coal measures both of Europe and of America. In his genera, Unger counts in the *Protopterideæ* of the coal, ten species only, distributed in five genera; and of these species, five are considered by Brongniart and Lindley as belonging to *Sigillaria* or *Lepidodendron*. Brongniart enumerates only six species of *Caulopteris;* Geinitz gives four, three of them published by Brongniart as *Sigillaria*, and one by Artis as *Megaphytum;* and Goeppert, in his 'Fossil Flora des Uebergangsgebirges,' has none. Some have supposed the genus *Psaronius* to be allied to *Protopteris*, and if so, the numbers of tree ferns would be much increased. Brongniart, however, looks upon *Psaronius* as allied to *Lepidodendron*. The cicatrices of *Caulopterideæ* are generally distant, placed on the stems in the spiral order $\frac{2}{5}$. When in a good state of preservation they are generally oval, or obovate, and elongated at both ends by a somewhat deep furrow. They have in the middle the mark of a simple bundle of vessels, in the form of a horse-shoe, and the central scar is surrounded by an oval annulus. The genus *Megaphytum*, according to Brongniart, ought to be united with the genera *Bothrodendron* or *Ulodendron*, and referred to *Lepidodendron*, as representing merely a modification of the last genus. Lesquereux, on the contrary, considers *Megaphytum* as a tree fern, and he is led to this conclusion from an examination of the cicatrices of *Megaphytum protuberans*.

Messrs. Cloez and Gratiolet find that the gas exhaled from aquatic plants exposed to the light in ordinary water slightly impregnated with carbonic acid contains besides oxygen a notable quantity of nitrogen. The latter gas they consider as proceeding from the decom-

position of the substance of the plant. They also maintain that the decomposition of carbonic acid by the green parts of aquatic plants, does not give rise to the formation of carbonic oxide as has been stated by Boussingault.

M. Cloez also says that the coloured parts of plants do not decompose carbonic acid so as to give off oxygen. If in some cases coloured leaves have been stated to do so, this depends he thinks on some green being present in them. He shows that in the coloured leaves of Amaranthus tricolor, the green portions only decomposed carbonic acid and gave off oxygen, while the yellow and red portions did not give off a single bubble of gas. These conclusions are contrary to the opinion of M. Theodore de Saussure.

IV. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

To chronicle with any degree of completeness the progress of a science which daily makes such advances as Chemistry, would require every quarter more than the whole of our space. We can only, therefore, continue to select those examples which seem to possess the greatest interest for general readers, and leave the special student of the science to seek the details in journals devoted entirely to the subject.

In general inorganic chemistry one or two interesting discoveries have been made. The first we shall mention is that of M. Lemoine, who has found that the red modification of phosphorus combines with sulphur in but one proportion.* The new sulphide has the formula P_2S_3. It is a remarkably stable compound, having a distinct crystalline form. It is remarkable also that this compound is always formed, whatever the proportion of the constituents may be employed in the experiment. This sesquisulphide of phosphorus, as we must call it, is soluble in sulphide of carbon, which affords a ready means of separating it from the uncombined red phosphorus. The fact that one element in an allotropic modification combines with another element in different proportions to what it does in the ordinary state, may not be without some significance.

Proceeding with the inorganic elements, we must notice the discovery of the metal cæsium in an unexpected place. It is now some years since Plattner analysed Pollux, a scarce mineral found in the island of Elba. He pronounced it to be a compound of silica, alumina, soda, and potash; but in his analyses he always had an inexplicable loss. Recently, M. Pisani † has analysed the same mineral, and has discovered that it contains 34 per cent. of cæsium; and calculating for this metal, the amount set down by Plattner as potassium, the percentage sum of the constituents is exactly made up.

* 'Comptes Rendus,' May 16.
† 'Comptes Rendus,' May 18.

Next comes the discovery of thallium in the Nauheim spring, in which cæsium and rubidium also exist. Professor Böttger* announces that thallium is present in the saline residue of the water in an appreciable quantity; but Werther, who has also examined the residue, states that he was able to obtain but a mere trace in 4 pounds.† Professor Schrötter, of Vienna, announces that he has also found thallium in lepidolite and mica. There can be no doubt that this metal is widely diffused in nature; but the means occasionally employed to separate it sometimes suggests that the thallium may have been conveyed to the substance in the reagents made use of. Böttger supposes that thallium always exists in pyrites in the form of thallium-iron alum, a salt, the composition, properties, and crystalline form of which have been recently determined by Messrs. Church and Crookes, and Professor Miller, of Cambridge.‡ The existence of this alum is held to support the hypothesis that thallium belongs to the series of alkaline metals; but by the same reasoning, silver may also be proved to be an alkaline metal, since Professor Church has recently§ made known the existence of a silver alum.

That the field of inorganic chemistry so far from being exhausted, is still capable of yielding rich results, has been once again proved by M. Marignac,‖ who has discovered a remarkable series of silico-tungstic acids, and described their compounds. We need notice but one of these bodies, most noteworthy from the extraordinary density of the solution it gives with water. *Silico-tungstic acid* is formed when gelatinous silica is boiled with an acid tungstate of soda or potash. It is composed of one equivalent of silica and 12 equivalents of tungstic acid, and is a very stable compound, forming hydrates, which can be obtained in crystals of large size. When in combination with soda the salt gives an aqueous solution, having the specific gravity of 3·05; in this solution, glass, quartz, and most stones will float. The solution, notwithstanding its great density, is very fluid, and it has been suggested¶ that it may form an excellent material for use in fluid prisms.

M. Kuhlmann has fallen upon some curious results in the course of investigations he has been led to make on the preservation of materials for building and ornamental purposes.

Some of these results are as important to geologists and mineralogists as to chemists, particularly those on the production of pseudomorphic crystals. By passing sulphuretted hydrogen over crystals of carbonate of lead kept at a moderate temperature, M. Kulhmann found that the carbonic acid in the compound was completely replaced by sulphur, while the crystal retained its original shape. Malachite treated in a similar way became converted into sulphide of copper,

* 'Proceedings of Manchester Literary and Philosophical Society,' March 22; and 'Journal für praktische Chemie,' No. 6, 1864.

† 'Journal für praktische Chemie, No, 7. 1864.

‡ 'Chemical News,' vol. ix. p. 205.

§ 'Chemical News,' vol. ix. p. 155.

‖ 'Comptes Rendus,' May 2.

¶ 'Chemical News,' vol. ix. p. 238.

which retained the fibrous and veined appearance which belonged to the original mineral.* The same author has extended his investigations to the colouring matter of precious stones with some unexpected results. The amethyst, for instance, he finds to be coloured by some organic matter, and not by a metallic oxide. For the author's mode of analysing gems of various descriptions, and the results, we must refer the reader to the original paper in the 'Comptes Rendus' for March 28.

Mr. Sonstadt, who has already achieved distinction as a manufacturer of magnesium, has now turned his attention to calcium, and succeeded in obtaining this metal in a tolerably easy way.† He first fuses together iodide of potassium and chloride of calcium, and then adds the mixture to sodium, and continues the heat, which need not be great. This, as the author states, is only a modification—in which, however, a serious obstacle is avoided,—of the method proposed by Liès Bodart, and Bodin.

Lastly, in the department of inorganic chemistry, we must notice the production by M. Peligot of some useful alloys of silver and zinc. The French Government is about to reduce the standard of the silver coinage, which disappears from circulation in consequence of the scarcity of the metal. M. Peligot, who is chemist to the French Mint, suggests that zinc should be employed in the alloy instead of copper. One great recommendation of such an alloy is, that it does not blacken when exposed to sulphur compounds, nor furnish verdigris with acid liquids; it is therefore especially applicable for watch cases, jewellery, and coins The best alloy we may say is composed of eight parts of silver and two parts of zinc.

Among the recently published results of investigations in the domain of organic chemistry, we may notice those of Cahours and Frémy on the respiration and maturation of fruits.‡ Cahours experimented upon apples and oranges, and found that when placed in a jar of oxygen or in mixtures of oxygen and nitrogen, the fruits absorbed the former gas and evolved carbonic acid. This went on and increased rapidly as the fruit ripened. In the expressed juices of the fruits he found carbonic acid and nitrogen, but not oxygen, hydrogen, or carbonic oxide. Further than this, he found that when the same fruits were placed in nitrogen or hydrogen, they still evolved carbonic acid, and the volume of the external gas increased. Hence the carbonic acid must have been produced by changes within the fruit and independent of the external atmosphere. The internal changes have been shown by MM. Chatin, Frémy, and Decaisne to consist in the oxidation of the immediate soluble principles. Tannin, it would seem, disappears first, then the acids, and lastly the sugar. These changes are well illustrated in the case of the medlar, which, when gathered, is very acid and astringent, and only becomes eatable after having been kept for some time in the air.

* 'Comptes Rendus,' May 17.
† 'Chemical News,' vol. ix. p. 140.
‡ 'Comptes Rendus, various, March, April, and May.

French chemists are still busily occupied with the phenomena of fermentation. The last experimenter who has taken up the subject is M. Béchamp, who attempts to show* that alcohol is a waste product of the yeast plant. His idea is that the plant first of all transforms sugar into glucose by means of peculiar ferment, which he calls *zymase;* it then assimilates the glucose and grows; finally, it throws out the alcohol and other compounds usually called products of fermentation, just as animals throw out waste products such as urea, &c. As a confirmation of this idea, the author asserts that the yeast plant throws out alcohol when not in contact with sugar or any fermentable material.

At the commencement of the present year, Mr. Smith, of Edinburgh, announced the discovery of a new alkaloid, in the juice of fresh aconite root. He named it *aconella*, and stated that in composition and all its chemical properties it was identical with narcotine, one of the opium alkaloids. Recently, Professor Jellett, of the Dublin University,† has investigated the optical properties of aconella and narcotine, and found that in those the two alkaloids (or one) are identical. The extraction of one and the same alkaloid from two such dissimilar sources, is, to say the least, extremely curious.

Everything that relates to the Cinchona plant, and the valuable alkaloids derived from it, is of so much importance to us, that we cannot pass over the communication of Dr. De Vry, recently made to a meeting of the Pharmaceutical Society.‡ The author, who is the able superintendent of the Dutch Cinchona plantations in Java, has recently paid a visit to the British plantations in Ceylon, and on the Neilgherry Hills. He confirms the report that these are in a most flourishing condition, and he obtained at them numerous specimens of stem and root barks which he has submitted to analysis. The most curious result of these analyses is, that quinine is found in the largest quantities in the bark of the root, a statement quite in contradiction to that of our English authority, Mr. Howard. But so certain is Dr. De Vry of his accuracy, that he goes so far as to suggest the cultivation of the plant for the root alone.

In analytical chemistry some useful information has been furnished by recent writers. When sulphuric acid in combination with the alkalies is estimated in the form of sulphate of baryta, some alkali is always carried down, which it is impossible to wash out, and which exaggerates the amount of sulphuric acid. A writer in 'Silliman's Journal,' makes known the fact that the alkali may be got rid of by digesting the precipitate in a solution of acetate of copper strongly acidulated with acetic acid. The mixture should be kept near a boiling temperature for ten or fifteen minutes, then, after well washing, pure sulphate of baryta will be left behind.

Winckler has recently published a method by which in assaying tin ores, the metal can be easily obtained in a single button. After having separated other metals in the usual way, he mixes the binoxide

* 'Comptes Rendus,' April 4.
† 'Chemical News,' vol. ix. p. 216.
‡ 'Chemical News,' vol. ix. p. 237.

of tin with a known weight of peroxide of copper, and reduces the two metals together. The copper carries down the tin with it in a single button, and the weight of the tin is obtained by subtracting that of the copper producible from the oxide employed from the gross weight of the button.

In connection with sulphuric acid we may mention the fact that Mr. Bottomley, of Manchester,* has proved the inaccuracy of Pelouze's method of estimating sulphur in ores by deflagrating them with chlorate of potash and carbonate of soda, and then determining the amount of undecomposed carbonate by a standard acid. Some oxygen compound of chlorine would appear to be always evolved with the carbonic acid, and the percentage of sulphur is always too low.

Sulphur is an important remedial agent, and in no form is more effective than in a mineral water. Dr. Sheridan Muspratt has recently analysed the water of the Harlow-car spring near Harrogate, and found therein nearly four grains of sulphide of sodium in the gallon. This water will probably be as highly valued as that of the neighbouring springs at Harrogate.

An ingenious, and no doubt, a reliable method of estimating tannic and gallic acids, has recently been published† by Herr Mittenzwey. It is based on the capacity of these bodies for absorbing oxygen in the presence of an alkali. The absorption is effected in a closed flask, a tube from which is opened in water that this fluid may supply the place of the gas taken up. The water is taken from a weighed quantity, and each gramme sucked into the flask will correspond to a cubic centimeter of oxygen at the normal pressure and temperature. Modifications of this process, the chemist will see, are applicable for the determination of iron and manganese, and also the valuation of indigo.

In the applications of chemistry we have not much to report. A process of considerable interest has been suggested by Mr. Whitelaw, of Glasgow, for the utilization of the brine from salt meat. He submits this to dialysis, and thereby separates the salt, and obtains the juices of the meat for soup. A further application of the process will serve to procure salted meat in an approximate state of freshness. The meat and brine are placed together in a dialysing bag, which is placed in water for a day or two. In this time most of the salt will have passed into the water, and the meat will be left, not exactly like recently killed, but still available for cooking in a variety of ways, to which salt meat is not adapted.

Proceedings of the Chemical Society.

Most of the papers read at the meetings of the Chemical Society, are of interest only to advanced chemists, and could not possibly be made intelligible to the general reader, so we give merely the titles as a record of the Society's proceeedings. The first is a paper by

* 'Chemical News,' vol. ix. p. 200.

† 'Journal für praktische Chemie,' No. 2, 1864.

Mr. E. J. Mills, On Nitro-compounds; another is On Oxyaniline, by Dr. Schmidt; a third is On the Subformiate of Ethyl, and On the Basic Salts of some Organic Acids; others were On the Hexyl Group, by Dr. Wanklyn; On the Action of Hydrobromic and Hydriodic Acids upon Polyatomic Acids, and On the Behaviour of the Iodo-substitution Compounds towards Hydriodic Acid. Lastly, we may mention the profoundly interesting discourse by Sir Benjamin Brodie, On the Organic Peroxides theoretically considered.

Beyond this we have only to record the discovery by Professor Tuson of crystalline organic principles in castor and croton oils. Contrary to expectation, it would appear that these principles produce no aperient effects; but as the President of the Chemical Society remarked, they deserve fuller investigation.

V. GEOGRAPHY.

(*Including the Transactions of the Royal Geographical Society, and Notices of the Ordnance Survey of Great Britain and Ireland.*)

No SCIENCE, probably, is more affected by political circumstances than geography. The development of mercantile speculation, war, and even the combinations and divisions of political parties and governments, each in their turn afford opportunities peculiar to themselves of acquiring fresh geographical information, and even of making some alteration in the physical contour of various countries. At the same time, it must be acknowledged that war especially throws many obstacles in the way of the investigation of distant lands; whilst mercantile pursuits not only interfere with those of a scientific character, but the spirit of greed that is apt to be developed where merchandize is a principle aim, frequently defeats its own object, and produces an exclusion from those very places which it was its desire to penetrate. As an instance of the service done to science by war, the insurrection in New Zealand has brought to light the great deficiency of good maps of that country. As the conquest of Seringapatam, by General Harris, led to the accurate survey and delineation of Mysore, so we may look forward to a lasting monument of the present unhappy squabble to be erected by the careful mapping out of the country traversed by the troops. The want has been strongly felt by the commanders, and it is to be hoped that they will take what means lie at their disposal to remedy the deficiency. In like manner we shall in all probability receive much additional information from some of the members of Mr. Eden's suite in his ill-fated expedition to Bhootan, and perhaps from the more military party that may have to follow in his footsteps. Under any circumstances, the north-eastern route to China is likely to receive some elucidation. But greater wars, such as the suicidal struggle in North America, on the contrary, paralyze all the efforts that used to be made

on that continent. We have no longer any of those elaborate and costly works, issued by the War Department of the United States, which once were a credit to the government that encouraged their production. For fifteen years the American Government published from time to time records of exploratory work done for them, the greatest and best probably being those of the expedition up the Colorado river of the West. All that we now get from North America is from surveyors in British Columbia and Vancouver's Island. One distinguished citizen of the Republic, Mr. George P. Marsh, who is well known in this country for his works on the English language and literature, and who is an accurate and extensive scholar of Norse literature, has written a volume, entitled 'Man and Nature, or Physical Geography modified by Human Action."* The object of this work is to estimate in some degree the character and extent of changes produced on the physical globe by human action, and to suggest the possibility and importance of the restoration of disturbed harmonies and the improvement of waste and exhausted regions. The book is written in a popular style.

It is an extraordinary circumstance that the two continents, in some respects so remarkably similar, Africa and Australia, furnish us now with most of the topics on which geographers discourse. The practical problem of how to produce the greatest amount of wool of a fine texture, and of late a similar search for land on which to grow cotton, combined with an outlet for our surplus population, has led to several attempts to penetrate into various parts of the interior of Australia, not leading to any very astonishing discoveries, but at the same time gradually adding to our knowledge of the geographical, and, as a necessary consequence, the geological peculiarities of this continent. The interior of Africa affords more reasons and encouragements to the discoverer. The very profitable traffic in its peculiar productions is attractive to one class of minds, but many more are led on by a sort of romance, a desire to penetrate into the unknown, to live a wild life, holding in subjection nature and nature's children, to discover some of nature's secrets; whilst others again, and these, perhaps, not the least heroic, are tempted to try and disseminate the seeds of Christianity and civilization amongst the wild tribes, whom one at least of the savants of the present day believes to be incapable of higher cerebral development without incurring the risk of falling forward and becoming a rational quadruped! Thus these two continents, each with its extraordinary fauna and flora, running back into ancient geological periods, each of a somewhat similar geological formation, consisting of an external ring of mountains, and enclosing great central plains, with rivers running inwards, and either drying up or terminating in central lakes, are the points to which our attention is now directed.

The colony of Queensland, at the present time, owing to the war

* 'Man and Nature; or, Physical Geography as Modified by Human Action.' By George P. Marsh, author of 'Lectures on the English Language,' 'The Student's Manual of the English Language,' &c. 8vo. Sampson Low, Son, and Marston.

in New Zealand, and the disturbing elements of gold digging in the other settlements of Australia, attracts considerable notice. We shall have occasion to speak at a later period of the surveys conducted by the governor of this colony. The settlers seem anxious to open out all the means of communication that they can. There is a design for a mail to Batavia to join the Dutch here. The coast will soon be defended by several lighthouses. The climate seems to afford great relief to persons afflicted with chest diseases, and the dugong oil is as efficacious a remedy as that of the cod liver. The cultivation of cotton is making a considerable advance, and bids fair in time to succeed to the now lost Sea Islands. Tobacco, and other productions of both temperate and torrid zones, flourish, and the only problem that remains to be solved is how far *north* the European can live with impunity. The Society of Arts at home has offered a prize for the discovery and working of a new coal mine in Australia. This has afforded much amusement to the colonists. They have no lack of mines, and mines in convenient localities; but the competition is so great that the chief difficulty is to find a market for the coal procured. Queensland promises in a few years to become one of the most flourishing of colonies dependent upon this empire.

The African explorers have been of late pressing in upon the unknown central region from all sides. Some hindrances seem likely to stop their very rapid progress. Dr. Kirk, who was attached to Dr. Livingstone's party, has returned, and Dr. Livingstone himself, the report of whose death has proved untrue, is on his way to Bombay, *viâ* Mozambique and Zanzibar, hoping at the former place to sell his little steamer, the 'Lady Nyassa.' Bishop Tozer, who was settled on the Zambesi, appears to meet with less success than he had anticipated, in consequence of the disturbed state of the country, and recommendations are being forwarded to him to retire to the frontier land to the north of the Zulu land. His object is to advance towards the interior, and his route need not be confined to any river or line of march. M. Jules Gérard has met with a repulse, too, from the King of Dahomey. He was indiscreet enough to write to 'The Times' an account of the custom on the ascent of the present monarch to the throne, and in consequence he has been politely requested to retire from the kingdom which he had begun to describe.

Dahomey itself has suffered a remarkable reverse at the hands of the Egbas of Abeokuta, who were so well described in Captain R. F. Burton's book on that subject, published last year. The old grudge which the traveller mentioned as having been nourished for more than ten years, has at last broken out into active warfare. With troops to the number, it is said, of 10,000, of which a large portion were Amazons, he attacked the Aro gate of the extensive fortified enclosure of Egba villages, that go by the name of Abeokuta, Under-the-Stone, a confederation of towns that remind us not only of the four or five hills that were first enclosed to make up Rome with its allied tribes, but also gives an explanation of some of those peculiar plural names that many Grecian towns possessed. Niebuhr found an explanation of Janus Biceps in a town lying inland on the northern coast of Africa;

a future critic of Livy and of Niebuhr may probably find other analogies between the form and government of the city of the Seven Hills, and the rudely defended haunt of Egba robbers, Under-the-Stone. For the present their Alban or Veientine assailant has been repulsed, and the Capitol, Olumo, the builder, stands firm. Other rumours of wars come from this neighbourhood. War was being carried on, and it is to be hoped is now stopped, against the King of Ashanti. Little is to be gained by throwing away in the swamps of Western Africa the lives of Englishmen, valued in this country, in the almost vain hope of destroying the lives of a few score black fellows whose lives are accounted nothing worth in their own land. Such is the common argument against this war, the justice or injustice of which we have not seen discussed.

There are in this country ambassadors from Madagascar, and in France some from Japan. The former are described as gentlemanly, intelligent men, evidently accustomed to the European dress, and at ease in European society. The predecessors of the latter have lately published their ideas of our characteristics for the benefit of their fellow-countrymen. The introduction to their book has been translated, and it is to be hoped that before long the whole of this interesting narrative may be reproduced in this country. Naturally the differences between their habits and our own attracted their attention, and in this way we learn much of those peculiarities which are most difficult for us otherwise to discover. Thus the height and massiveness of our houses struck them as remarkable, and suggested great danger in case of earthquakes, betraying the secret of their own low and slight style of architecture. Partitions of paper supported by a few slight beams, topped by a shingle roof of the lightest material, would topple to pieces like a card-house at the slightest vibration, but at the same time would do as little damage as the cardboard edifice itself. Their ceremonious behaviour towards their friends of various ranks was so remarkably different from our own unceremonious nod, or even more dignified bow, that they could not but remark upon our utter want of common decency according to their ideas on this matter. Foreigners are not likely soon to be excluded from these islands again, for the Mikado, the spiritual ruler and representative of the Conservative feeling, has given permission for them to remain five years longer. The lower classes show quite as much good feeling towards strangers. A sailor, one of fifteen belonging to the 'Star of Peace,' who alone swam to shore after the wreck of that vessel and the capsizing of the long boat, was most hospitably received by the inhabitants at Kadsusa, and at length forwarded to Yokohama. It is to be hoped that this kindly spirit may not again be disturbed by any champion of British independence, and that some consideration will be shown for the feelings and customs of the natives. The Prussian Scientific Expedition, which was sent a few years ago to Japan and China, is now preparing for the publication of the results of its discoveries. The artist announces a series of views, which are to be issued at the expense of the King of Prussia, in parts, the first of which is ready, and embraces six large views of Yeddo.

Should the inhabitants of the wonderful island of Madagascar seek to enlighten their countrymen and their lately resuscitated king on the subject of the northern nations that they are now visiting, we, too, may hope to learn something of the ideas, manners, and customs of that almost impenetrable country, whose inhabitants, animals, and flora differ so materially from the nearest approaching continent. In the meantime, we must content ourselves with the scanty information contained in such books as the 'Journal of the Bishop of Madagascar,'* in which we get only incidental remarks of any geographical value, since the work is rather addressed to those who are interested in missionary labours, than to scientific inquirers. Amongst other little known localities, The Curieuse, the isle of Lepers, a hospital island whither all these afflicted creatures are consigned by the government of the Mauritius, was visited by the bishop in the discharge of his episcopal and missionary functions.

The Royal Geographical Society.

Some extremely interesting papers have been read before this Society during the past quarter, amongst which Mr. Gifford Palgrave furnishes one on a journey from Gaza, through the interior of Arabia to El Khatif on the Persian Gulf, and thence to Oman. Under the disguise of a physician, a Syriac Christian, Mr. Palgrave passed through a highly-interesting and little known region. He left Gaza on the 5th May, 1862, went some little way along the pilgrimage route from Damascus to Mecca, passed within two days' journey of the Gulf of Akaba over a desert inhabited only by lizards and serpents, and entered the kingdom of Jebel Shomer. Here commenced his most remarkable discovery, *viz.* that among the strictest Mahometans, and amidst the strictest kind of dissenters from the orthodox form of this religion, there exist remnants of the old superstition which the prophet of Islam intended to extirpate. The worship of the sun, of trees, of fire, and of the north star under the remarkable name of Iah, the same word as that revealed to Moses, as described in the book of Exodus, all find adherents in out-of-the-way parts of Arabia. Amongst the mountains these ancient forms still hold their ground. After ten days' journeying, Mr. Palgrave and his companions reached the capital, Hail, where they were kindly treated by the king, Jelab. Hail contains about 20,000 inhabitants, with a good market-place, handsome shops, and a grand palace surrounded by fortifications. The government of the whole kingdom is well organized, though it was only founded sixty years since. From this kingdom of Jebel Shomer, Mr. Palgrave next passed to that of the sect of the Wahabees, which sect originated with a fanatical Mahometan reformer, Mohammed Ebn Abd-al-Wahab, about 100 years ago. This kingdom is an

* 'Mauritius and Madagascar: Journals of an Eight Years' Residence in the Diocese of Mauritius, and of a Visit to Madagascar.' By Vincent W. Ryan, D.D., Bishop of Mauritius. Seeley, Jackson, & Halliday.

equally good specimen of official centralization, and is a remarkable instance of a complete despotism, both as regards religion and politics. The religious practices of the Wahabees or Wahabites, are very peculiar. With them the next most heinous sin that can be committed after polytheism, by which they mean any kind of idolatry, is what they term "drinking the shameful," by which they designate smoking. Compared with this, murder, theft, false witness, &c., are venial sins; but this is not to be expiated in this world. In consequence of neglect on this point, and in the matter of wearing silk dresses, the cholera was supposed to have invaded the province some six years ago, upon which the king thought it advisable to appoint a council of twenty-two members, the strictest and most religious men that could be found, to inquire into the religious observance and morals of the community, and to inflict such corporal punishment as they deemed fitting. The king's own brother, and one of the principal ministers, a sort of First Lord of the Treasury, suffered this castigation,—the latter to such a violent degree that he died the next day. All the inhabitants of the town are obliged to attend prayers five times a day on pain of a beating. They attribute every action performed by man, animal, or physical law, to no intermediate cause, but at once to the Deity himself. As an instance of this, Mr. Palgrave mentions that a boy who, by way of introduction exhibited some dexterity with a top, addressed them as follows:—"Not by my strength, nor by my cleverness, but by the strength of God, and by the cleverness of God." In this remarkable country, previously unvisited except by the victorious arms of Ibrahim Pasha, were found the most celebrated of the celebrated breed of Nejed horses. The colour of these was mostly grey, a few were white or chesnut, still fewer black, and none bay. They were beautiful beyond compare, with clean legs, delicate muzzles, graceful haunches, well set-on tails, and very sloping shoulders. The king had 130 in his stables, which Mr. Palgrave, in his character of physician, visited on more than one occasion. These horses never find their way to Europe, as they are never sold or bartered. Leaving this neighbourhood with extreme difficulty, owing to a quarrel with the king, whom Mr. Palgrave refused to supply with strychnine for the but slightly disguised object of disposing of his own brother and some others of the great men of whom he was afraid, the party arrived at Khatif, on the Persian Gulf. The journey thence was undertaken by the companions separately to Oman, at the mouth of the Gulf, where they visited and were well treated by the sovereign. They finally reached civilization and rest at Bagdad, after fourteen months' constant travelling.

Two interesting papers on the sister colonies of Vancouver's Island and British Columbia were contributed to the Society by Dr. C. Forbes, R.N., and Lieut. H. S. Palmer, R.E. The outlines of the coast of these two colonies seem to be similar, and to resemble the north-western coasts of Europe. A rugged sea board westwards, indented with numerous fiords, backed by undulating ground further inland, gives to the island as different an aspect on the two shores as England itself presents. In the colony, the gentler slopes lead on

again to a second range of mountains, which develope at length into the Rocky Mountains. The climate in both cases is not vastly different from that of the Old Country, but the absence of the Gulf Stream, and the presence of currents from the Arctic regions, causes the temperature of the sea to be much colder than the ocean to which we are accustomed. In some respects the conchology is peculiarly boreal. Again, a great extent of snow-covered hill to the north of the colony causes cold but bright weather as late as Midsummer day. The principal wealth of both colonies seems to be mineral. Coal is found in some abundance in several places, and is of good quality. In British Columbia the principal attraction at present is the gold, which, according to Lieut. Palmer, promises the most inexhaustible field in the world. The veins appear to run north and south, but to be carried westward by the action of the torrents. The whole country produces magnificent forests, the trees of which reach enormous sizes; 300 feet is an ordinary height for a pine, whilst cedars reach the girth of 57 feet at a height of 5 ft. 6 in. from the ground. The country promises well for the farmer, being very similar in soil and production to our own land; but as yet there is little likelihood of much development of these resources, owing to the want of means of communication and the dearth of markets for the produce. A great number of Americans had emigrated to British Columbia, making excellent citizens, showing great enterprise, and exhibiting every disposition to settle permanently in the colony. The natives are, in the main, a peaceful and inoffensive race, though apt, if they consider their rights invaded, to retaliate in a manner consistent with the extremely degraded state of barbarism into which they have fallen.

Two papers on Queensland were read before the Society, one on an 'Overland Expedition from Port Denison to Rockingham Bay,' by A. J. Scott; the other was a communication from the Governor of the colony, Sir George Bowen, to the Duke of Newcastle, on the formation of a colony at Cape York, the northernmost point of the Australian continent, and on the survey of the inside of the Great Barrier Reef. The object of the former expedition was to discover a nearer approach to the sea from the Valley of Lagoons than Port Denison, which is 200 miles distant. Though no passage was made, an opening was discovered which only required that a certain portion of jungle should be cut through, in order to form a convenient road to the neighbourhood of Rockingham Bay. A continuous line of stations reaches northward of the Valley of Lagoons over a country well suited for Europeans, and for stock, and containing coal, iron, copper, and gold.

The Governor proposes a preliminary settlement on Albany Island, where the climate is remarkably cool for the tropics. There is abundant pasturage here for sheep, cattle, and horses, and large tracts for the cultivation of cotton, sugar, &c., and timber, stone, and lime exist in abundance. The survey of the inside of the Barrier Reef completes a most valuable and important work. It affords not only a safe means of communication between the colonies, but will undoubtedly in time become the route of the homeward-bound mails.

The reef acts as a natural breakwater, and keeps comparative still water within, the only disadvantage is the necessity of anchoring at night.

The subject of Nile discovery does not yet seem fully exhausted. Some of the reviewers of Captain Speke's book are inclined to dispute the fact of his having cleared up the whole mystery. The work of Phaëthon still remains uncancelled.

> "Nilus in extremum fugit perterritus orbem,
> Occuluitque caput, quod *adhuc* latet."

The captain is about to furnish further particulars in a pamphlet, entitled 'What led to the Discovery of the Source of the Nile.' In the meantime Mr. Petherick, late British Consul at Khartûm, has furnished the Society a paper on his journey with his wife and Dr. Muire up the Nile, from Khartûm to Gondokoro, in order to meet and assist the explorers. They sailed for some time up the river by the help of the north winds that blow continuously, but these at length failing, they were reduced to the necessity of making fast a rope to reeds, &c., and then hauling themselves along by means of this, being unable to tow from the nature of the river, which was here wide and shallow, and bordered by swampy marshes extending far inland. After proceeding some way in this manner, Mr. Petherick despatched an Arab whom he trusted, named Abd-il-Magd, to Gondokoro, to obtain tidings of Speke and Grant. Why he did not himself proceed on this expedition does not at present appear; and Captain Speke, in a letter to 'The Times,' complains that, as far as Mr. Petherick was concerned, he afforded him no assistance whatever; in fact, had it not been for his rival in trade, Mr. Debono, the East African expedition would have been considerably delayed, if not entirely frustrated. Mr. Petherick seems to have been deceived by Abd-il-Magd, who was carrying on a little secret traffic in slaves on his own account, and who returned without any news of the missing travellers. He reported indeed that obtaining no tidings at Gondokoro, he had gone thence westward to a place called Nyanbera, where the consul had a station, and from this place he had despatched some men southward, who were obliged to return in a few days, owing to the disturbed state of the country and their inability to procure better food than a few roots. These men report the existence of a large sheet of water flowing westward; but how much reliance is to be placed upon this evidence, we as yet know not. The rascality of Abd-il-Magd was soon discovered and properly punished. Mr. Petherick pursued his journey to Gondokoro, though he was obliged to travel by land westward in order to obtain porters, the demands for whom were exorbitantly high. He offered copper bracelets, but cows were required, and these were to be obtained only by a forage on territories of some of the neighbouring tribes, which he refused to attack. At last he procured both men and donkeys, and arrived at his own station at Nyanbera, and thence he proceeded eastward again to Gondokoro. Here he found Captains Speke and Grant already arrived, but of course he was too late to afford any material assistance; nevertheless,

his name and the news of his approach seem to have influenced the African potentates in releasing their guests, who were glad to be rid of their misplaced hospitality. Until the return of the consul to this country, it will of course be impossible to judge of the endeavours he made to assist the course of discovery. In the meantime there seems to be a probability that Captain Speke may again be leaving this country for the interior of Africa, not only under the auspices of the Geographical Society, but with some material assistance from the Emperor of the French.

Three papers on New Zealand have been read before the Society. They all referred to the Middle Island; the first being an Account of an expedition to the west coast of the Middle Island by Dr. Hector; the second, a Survey of the lake district of Otago, by James M. Kerrow, Esq.; and the third, On the southern Alps of Canterbury, Middle Island, New Zealand, by Dr. Haast. The mountains described in the first and third of these papers are extremely interesting. They rise somewhat near the west coast: first, in hills covered with beech forests; then, white-blossomed willows succeed; after that, rocky boulders announce real mountain scenery. These New Zealand Alps are remarkable for their glaciers, and are said to present a counterpart of what Scotland must have been in what is called the glacial age. The snow line appears to be about 8,000 feet above the level of the sea, but is higher on the north-western side than on the south-eastern, the former being the side most exposed to wind, and also to the moisture collected by the wind in its passage over the ocean. But though the snow line is so elevated, the glaciers push down into the valleys as low as 3,500 feet above the sea. A glacier, named after Dr. Haast at the elevation of 5,500 feet, is 500 feet thick. Another, the Tasman glacier, is 12 miles long, and at its lower extremity is a mile and three-quarters wide. The mountains themselves frequently reach the height of 10,000 feet in isolated peaks. The highest, Mount Cook, is 30 miles from the west coast, and reaches the elevation of 12,460 feet (just that of the Adler Pass between Saas and Zermatt). The character of the chain is peculiar—a long ridge accessible at most points, though reaching sometimes 8,000 feet, interspersed with higher cols, forms the watershed of the island—the streams on the western side running in torrents to the sea, whilst the eastern flow more gently over a greater extent of plain, and passing through some extensive lakes, which act as locks to regulate the pace at which the collected waters make their way to the sea. Some of these lakes are of great extent. The Te-Anan and Manipori lakes drain a district of many hundreds of miles. They exhibit traces of much greater depth in former times, and in some cases the rocks run sheer down to the water from some hundreds of feet high. Great numbers of very beautiful trees are found in various localities, fuchsia and *tutu* growing to trees with trunks of two feet in diameter; beech, pine, and *totaru* being plentiful.

A low pass has been discovered over the Andes by Don Guillermo Cox, whose paper, translated by Sir Woodbine Parish, was read before the Society. 2,800 feet was the altitude at which the summit was reached. The discoverer equipped an expedition at his own cost at a German

settlement called Montt, near the island of Chiloe, on the western coast, whence he proceeded towards the large lake of Naguel-huapi (Lake of Tigers). Here they found a river flowing eastward, which they descended; but at length their boat was capsized, and the party escaped, but only to fall into the hands of a cacique of a tribe of Pampas Indians, who wished to put Señor Cox to death, but was diverted from this by his playing on his flageolet. At last the cacique was induced to assist him as far as Rio Negro. The discovery was thus perfected, as well as that of a more northerly passage; but the utility of the discovery is at present dubious, in consequence of the hostility of the Indians.

This paper was followed by one on a railway over a northerly pass across the Andes, at a height of 16,500 feet, though a lower pass has been found a little southward; but this latter is not so practicable for engineering purposes.

Other papers read before the Society were, 'A Narrative of an Exploring Expedition into the Interior of Western Australia,' by Maxwell Lefroy, Esq.; 'An Exploration of the River Moisie to the Edge of the Table-Land of the Labrador Peninsula,' by Henry Yule Hind, M.A., Trinity College, Toronto; and one on 'The Frontier Province of Loreto, in North Peru,' by Professor Don Antonio Raimondy, of Lima.

The last proceedings of the Society that we have to record are the various ceremonials of the Anniversary Meeting. The report speaks of the pecuniary prosperity of the Society, notwithstanding very liberal grants to various travellers. The library and map room have received very considerable additions through the liberality of many donors. Premiums have been offered for instruments suitable for travellers, and a room has been set apart for the exhibition of such as are considered useful. The medals were this year presented—the founder's, to Baron von der Decken, for his remarkable journeys from the east coast of Africa to the mountains of Kilimandjoro, 20,065 feet above the sea level, and covered with perpetual snow—the patron's, or Queen's, to Captain Grant, the companion of Captain Speke, who last year was rewarded with the same recognition of his services whilst still at Gondokoro.

The President, in recounting the geographical discoveries of the year, descanted at some length on the discovery of the lake Victoria Nyanza, and other lakes connected with it or lying in the same region, and stated that the council had determined to offer 1,000*l.* towards an expedition up the White Nile, with a view of opening out the traffic with the interior, and extending the influence of the Pasha of Egypt in that direction, thus putting a stop to the horrors of the slave trade, which seems to infect all those who have commercial intercourse with the interior. Beyond this, the expedition is to explore the whole of this enormous lake (larger than Scotland according to Captain Speke), and gain all possible acquaintance with the physical geography of the neighbouring country. The President also gave a very elaborate account of the glacier system of the

Himalayas and the mountains of the Central Island of New Zealand, contrasting and comparing them with those of Europe, and showing their power in modifying the physical features of their respective regions.

The rule against the continued re-election of the same President has been suspended, and Sir Roderick Murchison again enters upon the duties of the office, which he has filled so ably during the past session.

The Ordnance Survey of Great Britain and Ireland.

By that large class who love good maps, the announcement that the Ordnance Survey of England is completed, and is soon to be within their reach, will be received with pleasure. This announcement is made in the Blue Book, reporting the progress of the National Survey up to the 31st of December, 1863; and in the course of another year or two, we may expect to have the maps of the six northern counties, which have been the last to be surveyed, issued to the public. These counties have the special privilege of being published on three different scales, namely, 25, 6, and 1 inch to a mile. It has always appeared to us that the first of these is unnecessarily large for a national survey, and is only justifiable for towns and special districts. For landowners it is, doubtless, a great boon to have a survey of their property made free of expense to themselves, and on a scale which would enable them to measure the breadth of a furrow in a ploughed field; but for the general purposes of the public such a scale appears absolutely useless, and we therefore maintain that the public should not be saddled with the cost of engraving maps from which they can derive no benefit. On the other hand, it may be replied that one survey is sufficient for any number of smaller scales, and that the measurements once taken for the 25-inch maps only require a proportionate reduction in the plotting for the smaller scales. Besides this, it seems probable that the produce of the sale of the 25-inch maps will ultimately cover the cost of publication; as the return of sale (including the value of those copies supplied to the public department) is set down for the past year at 2,135*l.* for England, and 2,624*l.* for Scotland.

The value of the maps on the 1-inch and 6-inch scales will not be disputed. As a matter of choice we should have preferred a 2-inch to a 1-inch scale, for the latter is so small in reference to the multiplicity of objects in populous districts that exaggeration and distortion cannot be avoided. This is particularly observable in laying down the turnpike roads, so as to distinguish them from country and parish lanes; on a scale of twice this size any undue enlargement would be unnecessary. We make these remarks because we feel satisfied that a re-survey of a large part of England will be undertaken on the completion of the whole kingdom. This is especially to be desired in respect of the southern counties of Cornwall, Devon, Wilts, &c., which were amongst the first to be surveyed, and the maps of which

in point of execution are very far behind those now being issued under the able management of Colonel Sir Henry James and his assistants. Indeed, we can scarcely speak too highly of the typographical accuracy and artistic skill exhibited in the hill-shading, and general portraiture of the landscape features in some of the more recently published 1-inch maps of the north of England and Scotland, arising from the general advance in this art, and the great care bestowed on the work, both in the field and in the offices of the survey. But beyond all this, it is scarcely to be endured that the great manufacturing and mining districts of Staffordshire, Warwickshire, Derbyshire, and South Wales should be put off with maps on the 1-inch scale alone—while other counties which have no higher claim in point of industrial pursuits, or extent of population, have the advantage of maps on much larger scales. In the mining districts of Lancashire and Yorkshire the 6-inch maps are general favourites, and are very largely used for colliery purposes. For the mining districts of the central counties and Wales, similar maps would doubtless be most valuable, but in order to their completion new surveys will, we presume, have to be undertaken, and the proposition we venture to make is this, that along with the 6-inch maps, others on a scale of 2 inches to a mile be published simultaneously. The 1-inch maps, both of the Geological and Ordnance Surveys, might of course remain as they are.

In Scotland the progress of the survey has lately been rapid, in obedience, we may suppose, to the demands of some of the Scotch Members of Parliament. The whole of the Lowlands, with the Highland districts of Perthshire, are surveyed, and are in course of publication on the three scales of 25, 6, and 1 inch to a mile. What may be the object of publishing parish maps of Highland moors and mountains on the 25-inch scale we cannot devine, except perhaps for the purpose of defining with accuracy the lands beyond which neighbouring sportsmen would be liable to penalty for trespass. It strikes us, however, that the 6-inch scale might have been sufficiently large for this purpose. Speaking from experience, we have never found any difficulty when traversing the moors of the north of England with the 6-inch map for a guide, in ascertaining exactly when we passed from one peat-bog to another across the narrowest possible ditch or line of demarcation, and in determining with certainty our position on the ground.

As regards Ireland, the plans of every county have been engraved and published on a scale of 6 inches to a mile, but as the plans of the northern counties, which were first surveyed, were made without that amount of detail which is now found necessary for the local valuation and assessments, these maps are being revised "at a great additional expense." Hence, as is frequently proved to be the case, it would have been cheaper in the end to have done the work well at the beginning. The whole of the 1-inch map is engraved and published in outline, and the engraving of the hills is being proceeded with.

Maps of most of the cities and towns of any importance in the three kingdoms are published, or drawn, on scales of 5 feet, or 10 feet to the inch; these have been proved most useful for the purpose

of sewage, water supply, repairs, and valuation. The following is a summary of the present state of the Ordnance Survey publications :—

ENGLAND.—Area, 58,000 square miles.

The whole has been surveyed, and, with the exception of a small part of the northern counties, is published on the 1-inch scale. The 6-inch maps of Lancashire, Yorkshire, Westmoreland, and Durham, containing 9,743 square miles, have been published; the engraving of those of Northumberland and Cumberland is far advanced. The six northern counties, and the southern counties of Essex, Hampshire, Kent, Middlesex, and Surrey, are being published on the scale of 25 inches to a mile.

WALES.—The whole principality is published on the 1-inch scale.

SCOTLAND.—Area, 30,000 square miles.

The 1-inch maps, with hill shading, have been published to the extent of 5,047 square miles, belonging principally to the shires of Ayr, Wigton, Kirkcudbright, Dumfries, Edinburgh, and Haddington, and the Isle of Lewis; while the whole of the tract south of the Friths of Forth and Clyde is engraved in outline.

On the 6-inch scale nearly the whole of the district south of the Friths of Forth and Clyde has been published, with the exception of parts of the shires of Renfrew and Lanark. Besides these, parts of Fifeshire and the Isle of Lewis have been completed, making in all 7,652 square miles.

On the 25-inch scale, plans of parishes for the counties of Ayr, Berwick, Dumbarton, Dumfries, Lanark, Linlithgow, Peebles, Renfrew, Roxburgh, and Selkirk, have been published.

Besides the above, the maps of Perthshire and Stirlingshire are in course of preparation, and the surveyors are carrying on their field-work amongst the highlands of Aberdeenshire and Argyleshire.

IRELAND.—Area, 32,813 square miles.

The outline maps on the 1-inch scale have been published for the whole country. The hill shading of these maps is in progress, and an area of 3,557 square miles belonging to the counties of Donegal, Londonderry, Meath, and Dublin has been published.

With reference to the 6-inch maps, it has been already stated that they have been completed for the whole country, but that those of the province of Ulster have been found to require revision. This has been, to a great extent, accomplished.

VI. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

WHILE new facts are generally more or less plentiful in all sciences of observation or experiment, new theories worth anything are few and far between, at any rate in Geology; and although every new fact must be to some extent an advance, a new theory may be, and often is, the cause of a decided retreat. But if a theory can withstand such a test as a well-directed effort at its proof, it may be considered an advance in science, as also may one which explains, or assists in explaining, in a rational manner, causes of phenomena hitherto obscure.

Of the many geological phenomena whose causes are still more or less obscure, that of the elevation and depression of portions of the earth's crust is one of the greatest importance, because of its being an element of change always present in the mind of the geologist, and one of the greatest difficulty because of the protean character of the circumstances attending its production, as well as on account of the numerous secondary results of which it is the proximate cause.

A new theory of elevation and depression has recently been propounded by Professor Bischof (in a second German edition of his 'Lehrbuch der chemischen und physikalischen Geologie'), who considers that all the observed phenomena can be explained by supposing them to have resulted from an increase or decrease of volume in deeply-seated rocks, in consequence of the more or less complete displacement of the silica of their silicates by carbonic acid. The chemical action and the physical result, which are together believed by the author to be the cause of the phenomena in question, may conceivably take place in nature, as we know that they can be produced by experiment.

Geologists have long been aware that the greater portion of the Scandinavian area has for ages been gradually rising at the rate of a few inches in a century, and this circumstance has hitherto baffled the ingenuity of every one who has attempted to explain it. But Professor Bischof's statement that the country is undergoing this upheaval only in those portions of it where siliceous rocks occur, renders it very probable that his theory will apply to a case of this kind, for he would scarcely make a statement of such importance had he not ascertained the fact to be such as he represents it. In a similar manner he explains the sinking of Greenland, the hydrous silicates which occur there undergoing a loss of volume through the displacement of the silica by carbonic acid.

It is, therefore, very probable that Professor Bischof's theory may be found to apply to such cases of gradual upheaval and depression, and thus it is surely a great advance in our knowledge of geological causes. Had the distinguished author been contented with this limited application of his hypothesis, we should not have been disposed to cavil at any of his arguments; but when he strives to account for the dislocation, contortion, and overturning of strata by merely supposing the upheaval to have been of unequal amount in different places, we confess that we are more than sceptical. It is easy for a chemist in his laboratory to propound such an hypothesis, but it is equally easy for a geologist in the field to see that it is very improbable, if not impossible.

Leaving now the region of theory, we may remark that the first announcement of a new and startling fact is often a much less important episode in the history of its discovery than the first attempt at its confirmation. The case which we are about to notice, namely, the discovery of fossils in the Laurentian rocks of Canada, well illustrates this proposition, for when the announcement was first made by Sir William Logan, nearly five years ago, at a meeting of the Ameri-

can Association for the advancement of science,* that one of the geologists of the Canadian Survey, Mr. John M'Mullin, had found some specimens in the Laurentian formation of Ottawa, which appeared strongly to resemble the fossils from the bird's-eye limestone known under the generic name of *Stromatocerium*, the statement, though printed in most of the scientific journals, received but little credence; but now that it is made for the second time, it has attracted the attention of most palæontologists, and won the belief of not a few.

One of the original specimens is figured in Sir William Logan's 'Geology of Canada,' and, as he observes, it certainly bears a wonderful resemblance to *Stromatopora*, which genus, we believe, is now thought to belong to the class *Polyzoa*. The Geological Survey of Canada has recently, however, had the good fortune to find other specimens of the same, or a similar organism, in the serpentine-limestone of Grenville; and as these specimens have been carefully prepared for a rigid examination, which has been undertaken by Dr. Dawson, F.R.S., F.G.S., who is well known as an able investigator of the minute structure of fossils, and who considers them to be *Foraminifera*, there appears to be no longer room for doubt as to their organic character, though until Dr. Dawson's figures and descriptions are published, the place they really occupy in the animal kingdom must remain uncertain.

The Laurentian rocks of Canada are older than any of the British strata, with the exception, perhaps, of some masses of granitic gneiss, which are supposed by many eminent geologists to be their equivalents, and which occur in the extreme north-west of Scotland and in the neighbouring isles. This statement may give some idea of the antiquity of the fossils, but their date is even more remote than would be supposed from a comparison of that nature, for Sir William Logan has recently discovered that the Laurentian system consists of two great groups, the upper of which—the Labrador series—rests unconformably upon the more ancient or Laurentian series, and it is in the latter that these fossils have been found. Below the whole series of British stratified rocks and their unconformities it is therefore necessary to add the Labrador series, then another unconformity, and another great series of rocks, and not until then do we arrive at the geological position of these old *Foraminifera*.

There is yet another point of interest connected with these ancient organisms, namely, their mineralization, Mr. Sterry Hunt having determined the substance which was formerly supposed to replace the calcareous skeleton of the animal, but which is now known to fill up the interspaces, to be true serpentine; so that, although it was pretty certain before, there can now be no doubt whatever that that rock is sometimes of metamorphic origin.

In a recent memoir, M. Alphonse Milne-Edwards discusses the 'Geological Distribution of Fossil Birds.' Although most of the fossil remains of birds hitherto discovered have been found in Ter-

* *See* 'Canadian Naturalist and Geologist,' vol. iv. 1859, p. 300.

tiary strata, yet they are known to have existed at a period as early, perhaps, as that of the Connecticut sandstone, the footprints so abundant in that rock exhibiting characters such as belong normally to this class only; but inasmuch as bones of birds have not yet been found in the same rock, the fact of the existence of such animals at this remote period, can scarcely, as yet, be considered established, although Professor Dana, in analysing a coprolite discovered near the footprints, found in it so large a quantity of uric acid as to render it probable that it had been formed by a bird.

If birds existed in the Triassic periods, their descendants or allies, must have lived during the deposition of all the succeeding strata; and, until the discovery of the *Archæopteryx*, this was the only reason that could be given for supposing them to have existed during the Jurassic epoch. The discovery of that noted fossil supplied a link, until then wanting, in the life-history of the class, and thus rendered the probability of the Connecticut footsteps being due to birds much greater than it was before, by diminishing, in a wonderful degree, the gap between the two oldest known indications of ornithic life. The *Archæopteryx* has been described scientifically by Professor Owen, and popularly by a dozen or so of *soi-disant* ornithologists, so that further notice of it need not be taken here.

Most of the bones of supposed birds found in Cretaceous strata have turned out to belong to other classes of animals, and in their investigation even Professor Owen appears not to have been free from error, as he described, under the name of *Cimoliornis Diomedeus*, some remains found by Lord Enniskillen in the chalk near Maidstone, which were afterwards shown by Dr. Bowerbank to be reptilian, and probably to belong to *Pterodactylus giganteus*. The result at which the author arrives is that the only undoubted evidences of Cretaceous birds are—(1), Their remains discovered by the late Mr. Barrett in the Cambridge Greensand; and (2), Those cited by Mr. Harlan from the Greensand of New Jersey.

Respecting the ornithic fauna of the Tertiary period, it must be sufficient to remark that remains of about 12 genera, represented by many species, have been found in the Paris Basin, besides at least seven kinds of tracks; and that the Miocene and later strata have afforded still more numerous remains, and the author of this paper indicates in it the characters of twelve new species from the Miocene strata of the Limagné. It must also be remembered that while a single species is of great interest when it constitutes all that is known of a fauna, it sinks into comparative insignificance when it forms, perhaps, but the fiftieth part of a known population.

M. Alphonse Milne-Edwards concludes his paper by observing—(1) That the existence of *Gastornis Parisiensis* and of the imprints of gigantic feet in the Paris gypsum shows that during Eocene times there existed a fauna at least as perfect as that of the recent period; (2) That the birds of the Miocene period differed but little from those of the present day, certain families, however, such as the *Phœnicopteridæ*, which are scantily represented now, being rich in genera and species then; and (3) That in the Quaternary period only the fauna of the present day

existed, such extinct species as occur in deposits of that age having since disappeared through the agency of man.

Dr. Duncan has given in full the results of his researches on the Fossil Corals of Scinde, in a paper which appeared in the April number of the 'Annals and Magazine of Natural History.' He finds that of forty-two species occurring in the Hala mountains, in Scinde, and in Cutch, fourteen of which are new, at least eleven species are not of Eocene date, notwithstanding that MM. D'Archiac and Haime appear to have ignored the occurrence of coral-bearing Miocene strata in the great chain of hills extending from the 'Salt-range' almost due south to Kurrachee, as they referred all such beds to the Nummulitic formation. It has for a long time been suspected that this so-called Nummulitic formation of India might include a later Tertiary deposit, as was originally determined by Messrs. Grant and Sowerby, and from what has recently been done it appears that there is now very little doubt as to the correctness of this view, notwithstanding the assertions to the contrary made by MM. D'Archiac and Haime in their great work on the fossils from the strata in question.

Mr. Searles Wood, jun., has this quarter published another contribution to the literature of the more recent strata, in continuation of those noticed in the last number of this Journal. From his researches, as detailed in his memoir "On the Belgian Equivalents of the Upper and Lower Drift of the Eastern Counties," published in the 'Annals and Magazine of Natural History' for May, it appears that the sands and gravels underlying the Boulder-clay in Norfolk, Suffolk, and Essex, to which he has given the name "Lower Drift," are probably the equivalents of the Campinian sands of Belgium; and that the Boulder-clay, or "Upper Drift," is the equivalent of the Loess of Belgium and the Rhine. This view differs essentially from that taken by many eminent geologists respecting the correlation of these deposits, and as the question rests entirely on stratigraphical and physical considerations, it can be discussed only by those who possess very considerable local knowledge of the deposits.

Mr. Wood's papers have, however, placed the matter on a footing somewhat different from that on which it rested previously to their publication, for he has applied the terms "Upper Drift" and "Lower Drift" to deposits which have until now been confounded together, with other more recent accumulations, under the general title of "Drift." So indefinite has been the meaning attached to this word "Drift," in respect of the age of the deposits to which it has been applied, that Mr. Wood does not appear to have been quite happy in his choice of terms; for if we confine the application of the term "Upper Drift" to the Boulder-clay, and of that of "Lower Drift" to the sands and gravels between it and the Red Crag, which have never before been treated of as a distinct deposit, what are we to call all those accumulations of sand, gravel, and clay, which are newer than the Boulder-clay, and to which the term "Drift" has hitherto been more commonly applied?

Proceedings of the Geological Society.

The last number of the Quarterly Journal of this Society can scarcely be said to be "full of interest" in other than a purely technical sense; but the Anniversary Address of the President, Herr von Koenen's paper on Oligocene Deposits in England, Professor Hind's remarks on Glacial Drift, and a memoir on Permian Rocks, by Sir R. I. Murchison and Professor Harkness, all contain matter of general interest; we shall, therefore, notice them first, and then discuss the Annual Report of the Council.

1. Professor Ramsay's Anniversary Address is prefaced, as usual, by the award of the Wollaston Medal and Donation-fund, the former of which was this year given to Sir R. I. Murchison; and were it not for the President's explanation—that the distinguished recipient had served uninterruptedly on the Council of the Society for thirty-two years, and was thus prevented from having conferred upon him before an honour he so well deserves—we should have marvelled at the omission. The accident of his temporary retirement from the Council, as one of its senior members, has been well and gracefully taken advantage of by his associates for the purpose of showing their appreciation of his vast services to geology in a manner so agreable to himself.

The Address itself is a continuation of that of last year, noticed in the last number of this Journal. As on the former occasion, Professor Ramsay discussed the "Breaks in the Succession of the British Palæozoic Strata," so in this Address he treats more especially of the "Breaks in the Succession of the British Mesozoic Strata;" but there are some collateral subjects discussed first, to which we must refer for a moment.

The first subject is that of the "Commencement of the Prevalence of Secondary Genera in Carboniferous Times," and it is certainly a remarkable one as treated by Professor Ramsay. Every disbeliever in cataclysms and sudden great creations must have long been familiar with the idea that some of the secondary genera appeared by degrees for the first time during some one or more of the Palæozoic periods; but, so far as we know, it has never before been shown what great fauna contains the first faint indication of secondary types. We may be certain of the existence of a needle in a haystack, but few of us have the energy or the skill to find it. But it is just such an operation as would be required in that case, that Professor Ramsay has performed with the vast mass of Palæozoic genera.

Referring, next, to the enormous lapse of time between the Permian and the Trias, as evidenced by "the disturbance, contortion, partial upheaval into land, and vast denudations which the Palæozoic rocks underwent before and during the deposition of the New Red Sandstone in the west of Europe," and as sufficient reason why there should be so great a difference between the fauna of the latest Palæozoic period, and that of the earliest Secondary epoch, Professor Ramsay then discusses the relations of the faunæ of the different Secondary formations

and their subdivisions. He bases his arguments upon the percentages of species common to the formations next in time to one another, as shown in tables perfectly bewildering in their complexity, and according as he finds them great or small, aided by stratigraphical considerations, so does he infer the existence or non-existence of an unconformity or of a break between them.

The two principal breaks shown to exist are—1. That between the Bunter and Keuper strata—represented on the continent by the Muschelkalk and the St. Cassian beds; and—2. That between the Oolitic and Cretaceous formations, which is represented, wholly or in part, by the Wealden and Purbeck beds.

In conclusion Professor Ramsay enunciates a general principle which he has inferred from his researches on breaks in succession, as follows:—"Making, as we can often do, all liberal allowances for diversities of marine and terrestrial conditions, I cannot resist the general inference that, *in cases of superposition, in proportion as the species are more or less continuous, that is to say, as the break in life is partial or complete, first, in the species, but more importantly in the loss of old and the appearance of new allied or unallied genera, so was the interval of time shorter or longer that elapsed between the close of the lower and the commencement of the upper formation;* and so it often happens that strata a few yards in thickness, or, more notably still, *the absence of these strata*, may serve to indicate a period of time as great as that represented by the vast accumulations of the whole Silurian series." Let him now calculate the age of the world who can.

2. Herr von Koenen's short paper, "On the Oligocene Deposits of Belgium, Northern Germany, and the South of England," is the result of a visit made by the author—a young German geologist—to the Isle of Wight and Hampshire, during which he managed to show, by means of fossils collected by himself, that certain strata known as the Middle Headon beds, which contain freshwater shells in the Isle of Wight, but marine fossils at Brockenhurst, belong to the Lower Oligocene formation of Germany. Of course Herr von Koenen advocates the adoption of Professor Beyrich's term "Oligocene," on the propriety, or rather the necessity, of which opinions are divided in England, but the question is too complicated to be discussed in an abstract. However, the paper shows us that in that often-explored region—the Isle of Wight and Hampshire—the young geologist may still be rewarded by making discoveries of interest.

3. In his paper on "Supposed Glacial Drift in the Labrador Peninsula, Western Canada, and on the South Branch of the Saskatchewan," Professor Hind describes phenomena, some of which occur on so grand a scale that, paradoxical as it may appear, they would be overlooked by the ordinary observer. Many of these phenomena have resulted from the operation of the forces that produced the present physical configuration of the surface. Of this nature are the terraces so abundant in the line of country between Lake Winnipeg, and the Grand Côteau de Missouri, in which region occur several precipitous escarpments facing North or North-east, the opposite face of the mountain always consisting of gently sloping plateaux separated by

terraces. These escarpments, though hundreds of miles in length, are all roughly parallel to one another, and appear to have a common origin. The author considers that they are all due to glacial action in some form or another, and he adopts Mr. Jamieson's explanation of the origin of the Parallel Roads of Glen Roy to account for the formation of the beaches and terraces of North America. The probability of their not being due to the action of the sea is increased by a very curious fact, namely, that in the state of Wisconsin there is an area of more than 3,000 square miles in extent, which is perfectly barren of drift and terraces, and in which no organic remains have been found other than those of Palæozoic rocks, with the exception of those of land-animals and plants. The inference drawn from these facts by the geologist who explored the region—Professor Whitney—was that this area has not been submerged since the Upper Silurian period. If this be so, of course the terraces, beaches, and drift in the neighbouring regions could not have been the result of the action of the sea, but must have been produced by a local cause; and the same inference will hold good if it can be shown that the driftless area of Wisconsin has remained above the level of the sea ever since the close of the Pliocene period, a conclusion much more likely to be accepted than the larger inference of Professor Whitney. The remarkable abundance of erratics in the regions described renders their absence in the "Driftless Area" still more singular, although in the valley of the Moisie they appear to be entirely wanting at less heights above the sea than 1,000 feet.

Professor Hind endeavours to explain all the phenomena, including beaches, terraces, escarpments, lakes, striæ, &c., as well as the forced arrangement of blocks of limestone (at an angle of about 45°) in Boulder-clay, by reference to ice-action, either direct or indirect; and he also reminds us that he promulgated the view that the great lakes were excavated by ice in the year 1859. His views regarding the particular form of ice-action by means of which lake-basins have been excavated appear rather improbable; he supposes that anchor-ice, formed in the rapid streams issuing from glaciers, may have begun the excavation by floating masses of rock from their beds to the surface, and that the glacier itself may have afterwards enlarged the depression. It is easy to see that the formation and action of anchor-ice could not be continued very long, as the process is self-destroying; for in proportion as the depression produced became larger and deeper, the quantity of anchor-ice formed would become less, that is, granting the author's own premises; and it seems scarcely probable that a glacier, if it can excavate a lake-basin, should do so at or near its termination, or where it is on the point of melting, its force being there reduced to a minimum.

4. The chief object of the paper "On the Permian Rocks of the North-west of England, and their Extension into Scotland," by Sir R. I. Murchison and Professor Harkness, is to prove that certain masses of red sandstone in the north-west of England belong to the Permian formation and not to the Trias. By this alteration in the classification of these rocks, which is necessarily founded on strati-

graphical considerations, the authors are enabled to show that the Permian strata of the north-west of England consist of three members, namely, the Rothliegende or Lower Permian, the Magnesian Limestone (Zechstein) or Middle Permian, and the sandstones in question forming the Upper Permian; and they bring forward this fact as an argument against the adoption of the new term "Dyas," proposed by Dr. Geitnitz. Whether this particular view of the relations of the Permian Rocks in the north-west of England be right or wrong, we do not see why an old-established name, against which there can be no possible objection that is not frivolous, should be abandoned for a new one, which is very likely not to be appropriate in all cases. The term "Trias" was adopted for two reasons: firstly, because it was proposed by von Alberti, who first clearly showed the relations and connection between the different members of the formation; and, secondly, because it was found to be appropriate. On the same principle, the term Permian, which was proposed by Sir R. I. Murchison, and has answered every purpose for so many years, having been used by every writer on the subject since it was established, may surely be allowed to remain now, when there is no good cause for displacing it; for although Dyas and Trias may sound well together, Geology is not Poetry, that it should reject reason for want of rhyme!

5. The Annual Report of the Council contains this year a *résumé* of the contents of the Society's Museum, in addition to the usual statements respecting the general condition of the Society, which appears to be extremely prosperous. The remarks on the Collections of Specimens of Rocks and Fossils are chiefly utilitarian in character, as they refer more to the value of the collections as materials for study, and to the facilities afforded by the Society for that purpose, than to the absolute scientific worth of the Museum. We very much doubt whether this is the legitimate light in which the matter should be looked at, but to discuss it thoroughly would require us at once to plunge into the depths of that fundamental question—What is the proper object for the Society to keep in view, as the end and aim for which they retain and keep in order a large Collection at a great expense. This matter, though very important to the Society, can scarcely be argued here; but so far as we understand it, it appears to us that the Museum of a learned Society is designed, not so much to instruct the tyro, as to form a storehouse of classical specimens, such as have been specially described in the Society's own publications or elsewhere, as well as those from remote and little known localities, which have never been determined. Of course, specimens for comparison are indispensable, but mere show-specimens and endless varieties of rocks and fossils from all sorts of localities—duplicates in all essential respects—are out of place.

The excellent collection of British Rocks and Fossils at the Museum of Practical Geology renders the Society's British Collection, so incomplete as it is, of comparatively slight value, and it seems a question worthy the consideration of the Council, whether it would not be advisable to re-arrange their British specimens on the same plan as that on which their Foreign Collection is now disposed,

rejecting all but type specimens, in which, especially those relating to the early days of the science, the Society is very rich.

These remarks have occurred to us from reading the statement respecting the present unsatisfactory condition of the Collection of British Rocks and Fossils, and contrasting it with the really useful manner, in which, thanks to the late Mr. Horner, their foreign specimens are now arranged.

VII. MICROSCOPY.

(*Including the Proceedings of the Microscopical Society.*)

The immense field of research which is open to the microscopical worker is daily entered upon by fresh labourers. The journals of Natural Science throughout Europe and America teem with new discoveries and new details of knowledge obtained by the use of this instrument. The length of our Chronicles, however, compels us to postpone many interesting facts to a future number, and we must content ourselves chiefly with a brief record of what is passing at home in accordance with the limited space at our disposal.

Professor Allman has recently shown that certain parts of the organisms of the Hydroida consist of Amœbiform protoplasm, and that pseudopodia in every way comparable to the pseudopodia of the Amœbæ are emitted from these masses. The singular bodies known as "nematophores," which are produced as buds at definite spots upon the hydrosoma of the Plumulariadæ, and contain clusters of large thread-cells, appear to consist of a granular protoplasm similar to that composing the Amœbæ. When examined in a trough of sea-water under the microscope, this mass of protoplasm may be seen to slowly elongate itself into variously-shaped processes, exactly like the pseudopodium of an Amœba. This occurs more particularly in *Antennularia antennina*.

Professor H. Karsten has been renewing his researches on the development and structure of the Vegetable Cell. His very lengthy and elaborate paper, containing as it does an interesting notice of original observations on this subject, has been translated in the 'Annals and Magazine of Natural History' for March and April.

The microscope, when applied to investigating the minute anatomy of the smaller forms of insect life, is sure to be productive of new and interesting facts; and it is, indeed, much to be desired that we had more observations of this nature on record. Dr. Leonard Landois has published a very complete monograph of the anatomy of *Ptharius inguinalis*, in which the minutest details of its structure and anatomy have been followed out with great care and highly interesting results. The blood of insects is one of those fluids among the invertebrate animals about which so much remains to be learned. Like the blood of vertebrate animals, it is corpusculated, and contains much mineral

matter. The fluids of the Annelida, though hardly comparable to the blood of the insect, also contain corpuscles, the intra-visceral fluid being the most remarkable on this account, whilst the respiratory fluid contained in distinct vessels is in general brightly coloured, and also, though less obviously, contains corpuscles. Dr. H. Landois has devoted considerable attention to the study of the blood of insects. By allowing the liquid to evaporate, he has succeeded in obtaining the various salts of the blood in a crystallized condition, and has been enabled thus to ascertain the nature of the mineral constituents of the blood in many of the commoner forms of Coleoptera and Orthoptera. They are found to differ in various species, as does also the form of the blood corpuscle.

We may notice here a form of microscope made by Mr. Ladd, of Beak Street, and specially adapted for use in museums and public galleries. Two of these instruments have for some time been in use in the Food Museum at South Kensington, and have answered their purpose most satisfactorily. The instrument is an ordinary compound microscope, with a revolving stage capable of receiving a dozen objects at the same time. By turning the disc, the objects are brought in succession under the eye of the observer. The focus is kept fixed, as is also the reflector, so that an inexperienced person cannot disturb the arrangement, which may be made by one of the functionaries of the Museum. If such instruments as these were placed in the galleries of the British Museum and such places of public instruction, supplied with suitable objects, it would add greatly to their general usefulness and interest. Among the various works which have been published during the past quarter, for the purpose of assisting the student in the use of the microscope, is one by Dr. J. W. Griffith, conjoint author of the 'Micrographical Dictionary,' entitled 'An Elementary Text-Book of the Microscope.' The figures, of which there are over four hundred, are very well executed, and contain drawings from among almost every class of objects likely to come under the student's observation. We notice the work fully in another section of this Journal.

The formation of societies intended to unite individuals engaged or interested in studies connected with the microscope must always be hailed with pleasure, as indicating an advance in the progress of Microscopical Science. A Microscopical Society has been formed at the University of Oxford, under the presidency of Dr. Acland, the Regius Professor of Medicine: many distinguished members of the university have joined the Society, and it is to be expected that an impulse will be given thereby to independent research, which cannot but lead to important results.

Microscopical Society of London.

Although the meetings of the Society have been well attended during the past quarter, yet few papers of interest have been communicated. Dr. Greville, who has worked so indefatigably at the group of the Diatomaceæ, continued his series of papers on "New and Rare

Diatoms." Indeed the deposit in the Barbadoes, from which most of his new species are derived, seems to be inexhaustible. Like similar deposits in the island of Mull, in Sweden, and the coast of Africa, the "Barbadoes earth" is composed of little else but the skeletons of these most beautiful and elegant plants. The abundance of species in a single locality is indeed very remarkable, for here is a truly fossil deposit, richer already in some extensive genera than any other known locality, while various genera of singular structure appear to be altogether peculiar to it. Forty-four species were detected some short time since in an examination of the water of the river Thames, as supplied to London by the various water companies, but here we have a variety of species which far exceed that number. The new species described by Dr. Greville belong to the genera, *Eupodiscus*, *Aulacodiscus*, *Auliscus*, *Biddulphia*, *Triceratium*, and *Entogonia*. Microscopists and naturalists generally are much indebted to Dr. Greville for the persevering manner in which he pursues his researches on this subject.

On the 8th of June a most valuable and important paper on "The Structure of the Sarcolemma of the Muscular Fibres of Insects, and on the Exact Relation of the Nerves and Tracheæ to the Contractile Tissue," was communicated by Dr. Lionel S. Beale, F.R.S., physician to King's College Hospital, and Professor of Physiology and General and Morbid Anatomy, in King's College, London. This paper contained new observations by the author relating to the mode of distribution of nerves to voluntary muscles. It is a continuation of his researches upon this subject, published in the 'Philosophical Transactions' for the years 1860, 1862, and 1863, and in the 'Archives of Medicine,' vols. iii. and iv. In the present communication he showed that the air-tubes or tracheæ ramified very finely over every part of the sarcolemma, anastomosing with one another, so as to form a network, the meshes of which were a little wider than the striæ of the muscle. The nerve fibres divided until very delicate ultimate branches, less than $\frac{1}{10000}$th of an inch in diameter, resulted; but each of these consisted of *a great number of individual fibres.* These branches appear to become lost upon the surface of the sarcolemma; but by examining specimens preserved in strong glycerin, and in which the contractile tissue had been ruptured at the moment of death within the tube of the sarcolemma, the bundle of nerve fibres was seen to break up into a plexus of extremely minute fibres, from which branches passed and ramified in the form of a network, or secondary plexus over every part of the sarcolemma. The appearances demonstrated in the author's specimens were utterly incompatible with the notion entertained by certain continental physiologists, that the nerve terminated by *free ends* upon the surface of the sarcolemma, or by blending with this structure; and also with the doctrine that the nerve perforates the sarcolemma and comes into actual contact with the muscular tissue.

The observations were made upon the common maggot or larva of the meat fly with the aid of powers varying from 1,000 to 2,500 linear.

The general conclusion is, that as in vertebrate animals, the nerve forms a network or plexus, which ramifies over every part of the

elementary muscular fibre; but the branches do not come into contact with the contractile tissue itself, or with its nuclei in any part.

These observations of Dr. Beale, in connection with his former researches, must serve to establish very important results with regard to the morphology of the nervous system. It seems to be now a definitely established fact that the ultimate fibres of the nervous cords do not end in free extremities, but form a connected network or plexus.

VIII. MINING, MINERALOGY, AND METALLURGY.

Mining.

The rapidity with which our blast furnaces swallow up iron ore naturally gives rise to much anxiety, lest the supply should be unequal to the demand.

Nearly *eight millions of tons of ore* are required to meet the present necessities of manufacture. Eagerly, therefore, are the native stores of iron ore sought out, and this eagerness is rewarded by many new and important discoveries.

At Belsdale, the place probably which was once worked by the Monks of Rivaulx Abbey, a large deposit of iron ore has been discovered. It had been traced in the Howardian Hills, the Derwent Valley, and near Malton. At Oldstead, near Coxwold, and at Keldy Castle, near Pickering, an excellent ore has been opened upon. We are gradually finding the links which form the chain of the vast deposits of ore extending from Whitby, with some brief interruptions due to geological changes, through Lincolnshire, across Northamptonshire and the adjoining counties, to Oxfordshire.

In the Western counties, a similar activity exists, and many new discoveries have been made. We are receiving some considerable importations of iron ore from Norway. This Norwegian ore is of a remarkable character, being, indeed, a titaniferous iron ore, much of it containing 30 per cent. of titanic acid. It is thought that this ore will be of great value in the manufacture of steel, and an English company is formed to work the Norwegian mines.

A series of experiments have been tried in Dolcoath Mine, in Cornwall, on the use of gun-cotton instead of gunpowder, in blasting the rocks. Baron Lenk's gun-cotton, as prepared by Messrs. Prentice and Co., was used, and the results were, on the whole, satisfactory; a larger quantity of rock being displaced with a quantity of gun-cotton less than one-half the weight of gunpowder required. We shall report all further experiments which may be made.

There are no novelties to record in connection with British mining. Nearly all our Mineral industries are, at present, working under the pressure due to the low prices of metal. There has been, and, to a certain extent there still continues, a great deal of unnatural excitement in connection with mining speculations. The result must prove to be, in every way, disastrous for the actual satisfactory exploration of

mineral districts. Gambling transactions, and they are nothing more, cannot be associated healthfully with any legitimate industry.

We had hoped the *Mines Commission* would ere this have made their Report to the House of Commons. We are informed that this Report, which is a most voluminous one, will be published during the ensuing month. It is unfortunate that the recommendations it may give, will not have the advantage of that consideration, during this Session of Parliament, which so important a matter, as the health of our mining population, demands. We hope that Lord Kinnaird, or some of the Members of the House of Commons, who are on this Commission, will embrace an early opportunity next Session of procuring some legislative enactments to prevent the recurrence of those conditions which are easily remediable, and which involve the loss of life and the destruction of health amongst the metalliferous miners.

We are pleased to see that Mr. H. Curwen Salmon has commenced a series of papers "On the Mines and Mining Operations of Cornwall."* No man can treat this subject more satisfactorily than Mr. Salmon, some of whose descriptions of our large and important mines have been very valuable contributions to this class of literature. At the Dudley Scientific Art and Industrial Exhibition, there was held a conference on Practical Mining. Mr. Rupert Kettle read on that occasion a paper "On the wasteful methods of working the South Staffordshire coals," and called attention to many sources of loss in connection with the system persevered in by the ground bailiffs of that district. There was some angry feeling manifested; but there is every reason for hoping that much good will result from this conference, and that the South Staffordshire coal proprietors, and the colliers, will have to thank Mr. Kettle for calling attention to their shortcomings.

Mr. Arundel Rogers, Barrister-at-Law, of the Inner Temple, has supplied a want in a very satisfactory manner. Few things are more obscured than the laws relating to Mining and Minerals. Mr. Rogers has endeavoured to give in a clear and comprehensive manner a statement of the laws of mines in England, Ireland, and Scotland.† Every one being connected with mining explorations, would act wisely to possess this work.

Having a remote connection with our subject, we may direct attention to a singular instance which has been brought forward to prove the preservative powers of the waters of old mines. M. Morin exhibited before the Academy of Sciences of Paris a piece of pine-wood, a portion of a wheel which has been found in an ancient mine in Portugal. It is believed to be at least 1,400 years old, and is now in a tolerably complete condition in the *Conservatoire des Arts et Métiers*. This preservation is due without doubt to the influence of solutions of sulphates of iron and of copper in the waters of this abandoned mine.

* 'The Mining and Smelting Magazine: a Monthly Review of Mining, Quarrying, and Metallurgy,' &c. May, 1864. Simpkin & Marshall, London.

† 'The Laws of Mines, Minerals, and Quarries in Great Britain and Ireland; with a Summary of the Laws of Foreign States, and practical directions for obtaining Government Grants to Work Foreign Mines. By Arundell Rogers, Esq. London: Stevens, Sons, & Haynes.

The writer of this notice has in his possession a piece of timber, believed to be oak, which was found in Pontpean mine, Normandy, where it had no doubt lain from the period when the Romans worked the mine. It is intensely black, but as solid as it ever was.

At the "Stream Works" for tin at Carnon and at Pentnam, in Cornwall, seventy feet below the present surface, oak shovels have been discovered which were probably used by the British miners who supplied the Tyrian merchants with tin. Similar implements have been found in the ancient mines of Dartmoor, and in the Roman mines of Cardiganshire. These instances sufficiently prove the preservative powers of the sulphates of the metals.

Mineralogy.

An interesting examination of some minerals of the chlorite group has been made by Mr. John B. Pearse.* The diversities of colour among the varieties of the mineral species are in many cases still unexplained. The Kämmererite from Lancaster county, Penn., for example, is of three kinds, one coloured pure green, a second red and green, while the third is pure red. Mr. Pearse's investigations were to determine the cause of this variation. We cannot transfer to our pages all the results obtained and the discussion on them; these must be sought in the original paper. The chief conclusion is, that "the cause of the difference of colour is unanswered by analysis. It is possibly due to molecular arrangement."

The name of *Grastite* is proposed for the new green variety, and Grastite and Kämmererite may be supposed to be formed thus:—

Grastite—1 atom of kaolin.	Kammererite—1 atom of kaolin.
2 „ olivine.	3 „ olivine.
5 „ brucite.	1 „ serpentine.
	5 „ brucite.

Mr. T. Sterry Hunt commences in 'Silliman's Journal' his "Contributions to Lithology."† No one has contributed more to the Chemistry of Rock-formations than Mr. Sterry Hunt; we may therefore regard those papers as valuable aids to our knowledge. Referring especially to the formation of granite, and to Mr. Sorby's discovery of fluid cavities in the quartz crystals,—one of the constituents of that rock,—Mr. Sterry Hunt has the following remarks, which from their high interest we think especially deserving of note:—

"The admirable investigations of Sorby on the microscopic structure of crystals, have demonstrated that water has intervened in the crystallization of almost all Plutonic rocks. He has shown that quartz, both of granite and of crystalline schists, contains great numbers of small cavities partially filled with water, or with concentrated aqueous solutions of chlorides, sulphates of potassium, sodium, calcium, magnesium, sometimes with free chlorhydric acid. . . . As these fluid-cavities enclosed the liquid at an elevated temperature, its subsequent cooling has produced a partial

* 'The American Journal of Science and Arts.' (Silliman.) Vol. xxxvii. No. 110, March, 1864.

† 'The American Journal of Science and Arts.' (Silliman.) Vol. xxxvii. No. 110, March, 1864.

vacuum, which is again filled on heating the crystal; so that the temperature of the crystals at the time of their formation may be approximately determined." . . . Mr. Sorby has determined this temperature, and "represents the lowest temperature at which the consolidation could have taken place, which varies from 340° C. to 380° C. in the Vesuvian minerals, and 356° in the quartz of the trachyte of Ponza; to the mean of 216° in the Cornish granites, to 99° in those of the Scottish Highlands, and even descends to 89° in some parts of the granite of Aberdeen. Mr. Sorby has calculated the pressure in feet, of rock, which would be required to compress the liquid so much that it would just fill the cavities at 360°C. The numbers thus obtained will therefore represent the actual pressure, provided the rock was in each case consolidated at that temperature. It would thus appear that the trachyte of Ponza was solidified near the surface, or beneath a pressure of only 4,000 feet of rock; while for the Aberdeen granite the pressure was equal to not less than 78,000 feet, and for the mean of the Highland granites 76,000. The Cornish granites vary from 32,400 to 63,000, and give, as a mean, 50,000 feet of pressure. In this connection Mr. Sorby remarks that, from Mr. Robert Hunt's observations on the mean increase of temperature in the mines of Cornwall, a heat of 360° C. would be attained at a depth of 53,500 feet."

In relation to this subject, the experiments made by Dr. Fairbairn, in Dukinfield Colliery, should be named. In a lecture on "Natural Laws"* recently delivered by that gentleman, the results are thus given. It should be stated that Dukinfield is above 2,100 feet, or upwards of 350 fathoms in depth. "The amount of increase indicated in these experiments is, from 51° to 57° 40′, from 20 to 693 feet below the surface, or 1° in 99 feet; but, if we state the results which are more reliable, namely, those between 693 and 2,055 feet, we have an increase of temperature from 57° 40′ to 75° 30′, or a mean increase of 1° in 76·8 feet. This rate of increase is not widely different from that obtained by other authorities, such as Walfeoden and Arago, who found an increase of 1° in 59 feet. Other experiments have given an increase of 1° in 71 feet." Dr. Fairbairn, with Dr. Joule, made an extensive series of experiments to ascertain at what depth beneath the surface of the earth the rocks would become fluid with this increase of temperature. "If," says Dr. Fairbairn, "we assume the rate of increase to be continued to a depth of nearly 3 miles, we arrive at the temperature of boiling water; at 39 miles we attain an amount of heat equivalent to 3,000°, which would melt the hardest rocks." The experiments to which we have referred were specially to determine if the melting point of bodies was influenced by pressure—the result was, "*an increase in the temperature of fusion proportional to the pressure to which the fused mass was subjected.*" "All these conditions tend to increase the solid thickness of the earth's crust, and we may venture to state that at a depth of 100 miles we should find a pressure equal to 1,200,000 lbs., or nearly 600 tons on the square inch." The ratio of increase in the temperature of fusion being 1° for every 500 lbs. pressure; therefore, taking 2,000° F. as the temperature of fusion at the

* Two Lectures on Iron and its Applications, &c., and on Natural Laws, delivered to the members of the Literary and Philosophical Society, Newcastle-on-Tyne, by William Fairbairn, C.E., LL.D., F.R.S., F.G.S.

surface of the earth, a temperature of 4,600° would be required at the depth of 100 miles. "Reasoning from these facts, we came to the conclusion that the earth's nucleus, under the enormous pressure to which it is subjected, may not be fluid but solid, or probably in a semi-fluid state."

In the Swiney Lectures on Geology, recently delivered by Dr. Percy in the Theatre of the Royal School of Mines,* the lecturer states, that there are many difficulties which have always stood in the way of receiving the hypothesis that granite is an igneous rock, "difficulties" known, at all events, to those who have been accustomed to make experiments on the fusion of minerals at high temperatures. This is especially seen by examining the condition of quartz; it is always found in the crystalline condition, and has invariably a specific gravity of 2·6. There is not a single instance known to the contrary. Hence there is reason to believe that the quartz never could have been fused, for the moment silica is fused, no matter in what condition it was previously, a peculiar glass-like colloidal mass is produced, having a specific gravity, which never exceeds 2·3. Therefore, there is good reason to conclude that granite could never have been formed under the condition of a high temperature.

Rammelsberg has recently presented to the Physico-Mathematical class of the Berlin Academy of Sciences a memoir upon the combinations of the oxide of lead and titanic acid which are found native.

Some very fine examples of the mineral vanadinite had been obtained from Windiskappel, in Carinthia.

We find an extensive examination of the vanadium minerals has been made by Czudnowicz.† He shows that the determination of vanadic acid in the *rhombic vanadinite* from Carinthia is incorrect, and the conclusions that the mineral was a simple vanadate of lead is not justified. His analyses show it to be a ter-basic vanadate of lead and zinc.‡

In the granite of the Island of Elba, associated with beryl, tourmaline, and quartz, two substances were found long since, to which the names of *Castor* and *Pollux* were given. These minerals were described by Breithaupt. and subsequently examined by Plattner. On the authority of this analysis Gmelin says, "Pollux appears to contain a larger quantity of alkali than any other known silicate mineral." It has now been more closely examined by M. Felix Pisani, and the results obtained by this chemist have been communicated by Henri Sainte Claire Deville to the Academy of Sciences of Paris. The analyses of Plattner and Pisani agree very nearly as far as the silica and alumina are concerned. In place, however, of the potash and

* These lectures have been most satisfactorily reported in the 'Chemical News.'

† 'Poggendorff's Annalen,' vol. cxx.

‡ 'Revue Universelle des Mines, de la Métallurgie, des Travaux Publics, des Sciences et des Arts—appliqués à l'Industrie,' sous la direction de M. Ch. de Cuyper. This journal contains several valuable papers on mineralogy, metallurgy, and mining, with notices of the allied science geology, and of the applications of science to manufacture. We shall, from time to time, avail ourselves of the useful matter which this journal may communicate.

soda of the former, M. Pisani has given *oxide of cæsium*, which metal was mistaken for the alkalies by Plattner. This is the first mineral discovered with a known base of the new metal cæsium.

M. Pisani has also discovered cæsium in the rose lepidolithe or lithia mica of Elba, and with it a considerable quantity of the metal rubidium.*

Sources from which the new metal *thallium*—which was discovered by Mr. Crookes—may be obtained, are increasing upon us. Mr. Emerson Reynolds informs the *Royal Geological Society of Ireland* of the existence of a thalliferous pyrites in Ballydehob, county Cork; and M. Schrotter announces to the *Imperial Academy of Sciences of Vienna* the presence of this metal in the *lepidolithe* of Moravia (a lithia mica) and in the *mica* of Linnwald, Bohemia.

'A Popular and Practical Exposition of the Minerals and Geology of Canada' has † been published by Professor Chapman. This volume gives a popular, yet full sketch of the Mineralogy and Geology of Canada.

Mr. N. S. Maskelyne communicates ‡ the discovery of a new mineral from Cornwall, "prismatic, in crystalline form, and consisting probably of a basic sulphate of copper, insoluble in water. It occurs in minute but brilliant crystals, and in fine masses of the richest blue colour; it forms a thick incrustation upon a tender killas."

The phenomenon of asterism in natural crystals will be familiar to most persons; it is not so generally known that this may be produced artificially. Rose showed long since that the star of mica could be produced upon isinglass by impressing the mica on it. G. A. Grüel § gives a very simple method for producing asterism; a piece of glass is cut into a triangular figure, and then rubbed backwards and forwards a few times on a sheet of fine emery paper, each of the three sides being successively guided against a metal rule, which, at the same time being pressed on the emery paper, keeps it in position.

We have found that we may obtain glasses exhibiting any number of radial lines by fixing the glass on a lathe. The lathe enables us to produce a figure with any number of sides, and the application of the emery paper or a fine file, parallel to each side, is carried out without difficulty.

A lignite of superior quality is said to have been discovered in the Punjaub. This discovery has been made about 150 miles north of Lahore, upon the borders of Jhelum, a little to the west of the road to Peshawur, nearly on the line of the railway projected by Mr. Andrews from Lahore to Peshawur. It has been analysed for the Railway Company, and it is said to be for use in locomotive engines superior to the coal found in Bengal. This lignite is therefore necessarily exciting considerable interest, for if it exists in large quantity, which is said to be the case, it will materially facilitate the extension of the railway system in the Punjaub.

* L'Institut, and Les Mondes.

† By E. J. Chapman, Ph.D., Prof. University College, Toronto. Toronto, 1864.

‡ 'Philosophical Magazine,' No. 182, April, 1864.

§ 'Poggendorff's Annalen,' vol. cxvii. p. 635.

Metallurgy.

Various attemps have from time to time been made to obtain malleable iron or steel directly from the blast furnace. A few only of these experiments can be regarded as having been successful. At the present time arrangements on a very large scale are being made in immediate connection with the Barrow Hematite Iron Works of Messrs. Schneider and Hannay, to receive the cast-iron directly from the blast furnaces into the "converters" of the Bessemer process, and thus produce steel without allowing the melted mass to cool. On the Continent this is adopted in many of the larger iron-producing establishments, and we hear of several works about to be erected in this country, by which, without doubt, steel will be produced at a cost but a little exceeding that of cast-iron.

M. Lamy has been carefully studying the conditions of iron produced in the blast furnace. He notices a loss sustained from the cast-iron meeting with an oxidizing heat and atmosphere in the hearth, causing part of it to pass into slag. Again, in refining, the iron is fused under an oxidizing flame, by which about 10% is scorified. In puddling, the process is carried on in an oxidizing atmosphere with a further loss. M. Lamy estimates the total loss in converting pig-iron into wrought-iron as not less than from 15% to 20%. He therefore proposes to combine the three operations in one, or rather, as we understand it, to carry out the three operations consecutively in the same furnace. The apparatus proposed consists of two distinct parts; one placed above the other. The upper furnace is the blast furnace in which the iron is smelted from its ores; this part differs from the ordinary blast furnace in the body and boshes being formed of distinct truncated cones—connected by their bases—but separated from each other by an opening, which the inventor calls the *pyrote*. The twyers are in the upper part of the boshes, and the blast is directed downwards. The hearth is formed of a slightly inclined plane, which leads to the lower apparatus. This is essentially a turbine of wrought-iron attached to, and moved by, an axle protected by solid masonry; this works on a platform furnished with several ranges of perpendicular knives, which are for dividing the metal driven out by the centrifugal force of the turbine. On each side are two fireplaces, arranged so as not to give off oxidizing gases.

When the furnace is charged, the blast is turned on by the upper twyers, and thus a high temperature is produced in the boshes. The oxidizing atmosphere is changed into a reducing one by the conversion of the carbonic oxide into carbonic acid. The iron ores, therefore, in descending, only meet with reducing gases, and the product perfectly liquified flows along the inclined plane to the crucible, and may, if the object is to get cast-iron, be tapped in the usual manner. When wrought-iron is to be made, the melted cast-iron is directed on the centre of the turbine, which is in motion, and air and superheated steam are turned through twyers fixed at the lower part of the furnace.

The cast-iron is divided by the centrifugal motion, and is brought into contact with an oxidizing atmosphere, the air acts on the carbon

and silicon, and, it is said, the stream on the phosphorus and sulphur, so that refined iron is produced very rapidly.

In the third stage of the process, the carbon of the cast-iron acts on the bed, which is composed of rich slags and sheets of wrought-iron, and after "rabbling," the puddled ball is ready for shingling. When it is required to make steel, the coverings of the sole (rich slags, &c.) are omitted—the rotation of the turbine is accelerated, and the blast in the twyers increased.

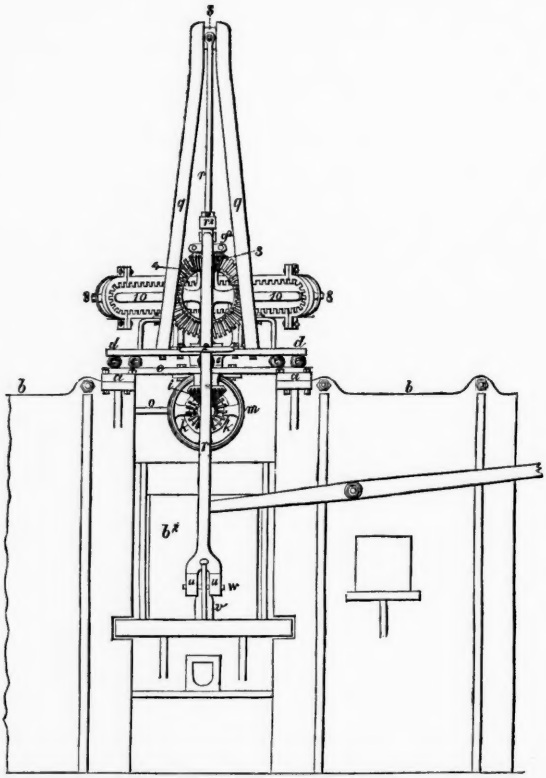
We are not aware of any experiments, on a large scale, having been tried, except by M. Lamy himself, but there is so much ingenuity in the arrangements, and each stage of the process has been so carefully studied that, except there are mechanical difficulties in the way, it appears to promise a successful issue, and much economy.

The most severe labour to which man is subjected is, that of puddling iron—the process by which pig-iron is converted into malleable iron. The "puddler" has to manipulate balls of iron, weighing from 2 cwt. to 3 cwt., in front of an intensely heated reverberatory furnace. Many schemes have been devised for performing this operation by machinery, but hitherto it does not appear that any of them have been successful. In 1861 a patent was secured by Mr. W. H. Tooth. Dr. Percy, in his "Metallurgy," notices the fact, but he gives no indication of the character of the machinery employed, or of the results of its application. It may, therefore, be concluded that it did not answer the desired end. Mr. James Nasmyth sought to facilitate the process of puddling, by the introduction of steam "to mechanically agitate the molton iron, and thereby keep exposing fresh surfaces of the iron to the oxygen of the iron contained in the atmosphere passing through the furnace." This process has not, as far as we know, been successfully applied in any of our iron works.

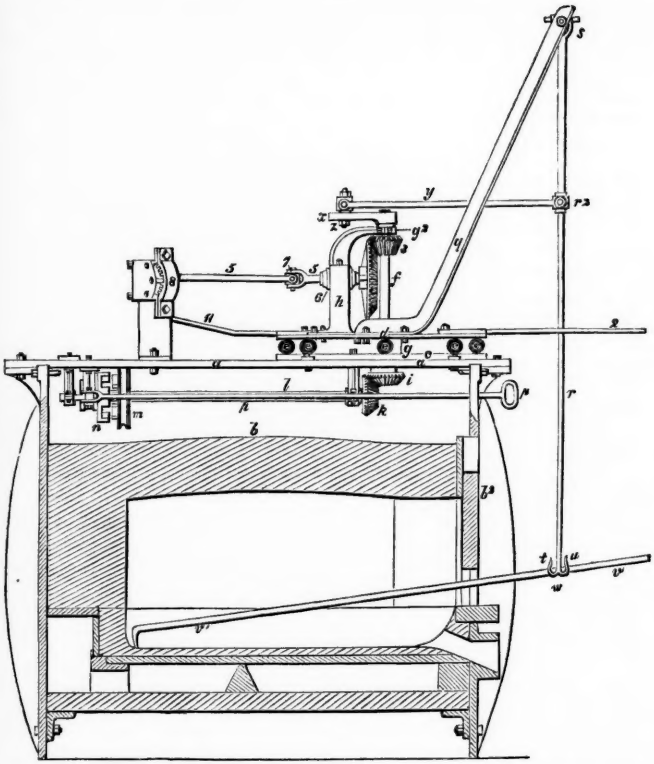
The latest attempt to apply machinery for puddling iron is, that of Mr. John Griffiths. This application is more promising than any which have preceded it, and is now, we are told, on trial in several works.

The puddling process consists in stirring the melted cast-iron on the bed of a reverberatory furnace, so as to expose it to the action of the air. This is usually performed by means of a stirring tool, called a rabble, by which the workman stirs the melted iron. Mr. Griffiths, by means of machinery, gives nearly the same motion to a rabble as is given to it by the puddler, and the puddling is effected without manual labour, or nearly so.

The construction of the machinery will be easily understood by reference to the accompanying woodcuts (pages 494 and 495). *a a* are two cross bars fixed on the furnace *b*, on which rests a circular bed-plate *c*, above which is another circular plate *d*, which has a reciprocatory motion through about a quadrant. This upper plate *d* is supported on the bed-plate *c*, by spheres or balls *e*, which move in a groove. A vertical shaft *f*, working in the bearing *g*, in the bed-plate, passes through and works loosely in the movable plate *d*. This shaft below the bed-plate *c* carries a bevil-toothed wheel *i*, which gears with another bevil-toothed wheel *k*, on the horizontal shaft *l*,



from which the several motions of the machine are derived. Rotary motion is communicated to this shaft by a chain or band from a prime mover, passing over the loose clutch pulley *m*, near which is a fixed clutch *n*, capable of sliding on a feather on the shaft, and by means of the forked lever *o*, and rod *p*, it can be thrown into and out of gear with *m*, and motion communicated to the horizontal shaft, or arrested. To the movable plate *d* is fixed a jib *g*, which projects 18 inches beyond the furnace door, to this by a socket-joint *s*, is suspended a hanger *r*, which moves both longitudinally and transversily. The lower end of this hanger is made into two forks *t*, *u*, one on each side, into one or other of which forks the puddling tool or "rabble" *v*, can be jointed by the axis *w*. This description, with the woodcuts, will enable the reader to understand the principle of this invention, the object of which is to impart to the puddling tool a backward and for-



ward motion in combination with a reciprocatory motion of partial rotation. It would be tedious to describe minutely those parts, through the agency of which these motions are obtained. To the mechanic those parts of the machine marked with numerals from 1 to 11, will sufficiently explain themselves, and to those who are not familiar with the detail of gearing machinery, a brief description would not be intelligible. The end to be attained in a machine for puddling is to communicate to the "rabble," or puddling tool, every motion which can be given to it by a man. Mr. Griffiths has certainly devised a machine which gives most of them. It will be understood that by the combined motions the puddling tool is made to travel up and down, and across the furnace. The main question is, whether this or any other machine can substitute those motions which are dependent upon the trained skill of an experienced puddler, and on which depends the production of good or bad iron.

In order to facilitate the process of oxidation, and to refine the iron, Mr. Griffiths substitutes, at the proper times during the process, a *hollow* rabble, or puddling tool. The object of this being to convey air, either hot or cold, to the iron, this blast being supplied to the hollow tool by a flexible tube capable of ready attachment to, and detachment from, the tool.

In the *Annales des Mines* in 1862,* MM. Dumeny and Lemut described a mechanical puddler which had been adopted at the Clos-Mortier Forges, Haute Marne. Even then the inventors conceived they had obtained an improvement in the quality of the products, an economy in the consumption of materials, and a diminution in the labour of the puddler. In a recent number † of the same journal, M. Lemut informs us that the result of working at seven furnaces fitted with the mechanical puddler is so satisfactory, that there is no hesitation felt in applying them without further modification to all the other furnaces. In the present state of things in this country, it is very important to obtain the advantage of the experience of two years' practice in large and well-conducted forges. M. Lemut gives the following summary :—

The consumption of fuel for each ton of malleable iron made is considerably reduced.

Economy is effected in the general expenses, as the work is accelerated, and the production of each furnace increased.

The "underhand" is dispensed with, and the labour of the puddler is diminished.

But, he says, the improvement in the quality of the iron is the most important result of mechanical puddling. Grey pig-iron made with coke, which was difficult to refine under the action of three or four heavy rabbles, "came to nature" in a very short time with the addition of cinders, and produced iron of a superior quality.

It may be incidentally noticed that, on the Continent, considerable attention has lately been given to the construction of the blast furnace. In 1859, Mr. Alger, an American ironmaster, formed a company for introducing a new form of furnace, the hearth being an elongated ellipse. Although some experiments made appeared to indicate a favourable result, this furnace has not been, in this country, adopted. A Russian mining engineer, General Wladimir Rachette, showed at our Exhibition of 1862, a model of his new blast furnace. This did not excite much attention in this country, but in Russia and in Germany some of Rachette's furnaces have been constructed, and the results are said to be in every way satisfactory. Like Alger's furnace, Rachette's has a hearth of a narrow and elongated section. A good account of this furnace and its applications has been given by Dr. L. Beck, of the Metallurgical Laboratory, Royal School of Mines.‡

M. Eugène Peligot has recently brought before the Academy of Sciences, of Paris, the result of his experimental researches on the alloys of zinc and silver, and of silver and copper. These examina-

* 'Annales des Mines,' 6th series, tome ii. 1862.
† 'Annales des Mines,' 6th series, tome iv. 1864.
‡ 'Mining and Smelting Magazine,' April, 1864.

tions have been made with a view to some alterations in the French coinage system. An alloy prepared with 835 parts of silver, 93 parts of copper, and 72 of zinc, presents many advantages. The fact that this alloy is obtained by adding 77 grammes of zinc to each kilogramme of the existing money, is considered a strong recommendation. All the alloys of silver with zinc are found to be perfectly homogeneous, and for coining possesses all the advantages which belong to the alloys of silver and copper, giving a metal, at the same time, of a fine white colour.

An alloy of 850 parts of silver, with 150 parts of zinc, is said, from its fine colour, to be well fitted for bijouterie.*

IX. PHYSICS.

Light.—Since our last Chronicles of the progress of optical science, many interesting researches have been made, foremost of which should be mentioned the striking discovery by MM. Plucker and Hittorf, that certain bodies, such as nitrogen and sulphur, give two very different spectra, according to the temperature to which the incandescent vapour is submitted. To show this, they pass through the tubes (containing the gas or vapour in a highly rarefied state) the ordinary current of an induction coil; in this manner they obtain what is named the *first* spectrum, formed of large bands more or less regular, and often presenting the appearance of channelled spaces cut out by black rays. This corresponds to the lowest temperature. By interposing a Leyden jar, and varying the surface of this jar, the calorific action is likewise varied; in this manner, by gradually raising the temperature of the gaseous body, they find that at a certain point an essential modification takes place in its molecular constitution, and another and entirely different spectrum suddenly takes the place of the former one. This *second* spectrum, corresponding to the higher temperature, is generally characterized by brilliant rays on a more or less luminous ground. Sulphur shows in a striking manner the abrupt passage from one spectrum to the other. Upon gradually increasing the temperature, the first spectrum gets brighter and brighter; when at the moment it attains its maximum of brilliancy, it suddenly disappears and gives place to the second spectrum, the richest in brilliant rays which the authors had ever seen. On lowering the temperature, the second spectrum disappears equally suddenly and gives place to the first.

Nitrogen gives *three* spectra, showing three different molecular conditions. Naming these according to the general character of the bands they show, MM. Plucker and Hittorf consider that nitrogen has two distinct *first* spectra,—one of a yellow colour, corresponding to the less degree of incandescence, and the other of a blue colour, corre-

* 'Les Mondes, Revue Hebdomadaire des Sciences,' tome iv. 15 livraison. 'L'Institut, Journal Universel des Sciences.'

sponding to a higher degree of incandescence. The *second* spectrum is produced by a very much more intense heat than that required to show the two *first* spectra. Oxygen, chlorine, bromine, and iodine have only one spectrum.

Mitscherlich has found that when a drop of a solution of chloride of barium mixed with sal ammoniac is introduced into the flame of a spectroscope, two brilliant green rays, having no connection with the barium spectrum, make their appearance. Sometimes these two green rays are unaccompanied by the barium spectrum, and sometimes they are superimposed upon it. He also finds that most metallic spectra are modified by the presence of hydrochloric acid, or chloride of ammonium vapour; in some the lines entirely disappear, while in others new lines make their appearance. He explains this by assuming that in the one case the spectrum is that of the metal itself, whilst in the other it is that of the compound.

The spectrum of carbon has attracted considerable attention lately. From an examination of the spectra produced by carbonic oxide, carbonic acid, sulphide of carbon, cyanogen, and olefiant gas, either ignited in the air or rendered incandescent by the spark of an induction coil, Dr. Attfield was led to the conclusion that certain lines which were common to all of these compounds were due to carbon, and constituted the spectrum of this element. M. Morren, in examining a candle flame, finds that the blue portion at the base of the flame "is the vapour of carbon preserved from combustion, but kept at a very high temperature by the envelope of hydrogen." M. Morren leaves us in the dark as to how the carbon gets into this vaporous state, neither does he explain how it is that the low temperature of the blue part of the candle flame is hot enough to keep free carbon in a state of vapour, when it is notorious that the highest artificial heat yet produced is insufficient to effect this. According to Dr. Roscoe, the spectra which these various forms of carbon compounds give when in the state of incandescent gas are not quite identical. Thus, the so-called carbon rays obtained with the flame of olefiant gas differ from those obtained by the electric discharge through a vacuum of the same gas; whilst a spark passing through a cyanogen vacuum produces a spectrum identical with that of the olefiant gas flame, and the spark through a carbonic oxide vacuum gives a spectrum coincident with that of the olefiant gas vacuum.

A series of experiments on the intensity of the solar radiation has been made by Father Secchi; his apparatus consists of two cylinders placed one within the other, the space between the two being filled with water at a certain temperature. The aperture of the inner cylinder is closed at one end by a plate of glass, and the other is partially closed by a diaphragm with an aperture; a black bulb thermometer is placed in the axis of the inner cylinder. On exposing this instrument to the sun, it was found that the same difference of temperature between the black bulb thermometer was always maintained, whatever was the temperature of the water, and that the sun at mid-day produced no

greater difference between these two temperatures in summer than in winter, although in the latter case the rays have to travel through about twice as much atmosphere. The explanation of this is, that there is more aqueous vapour in the air in summer than in winter, thus fully bearing out the observations of Professor Tyndall as to the power of the vapour of water to intercept the sun's rays.

A discussion has been going on between MM. Van Monkhoven and Bertsch on the possibility of constructing a system of lenses which will augment the intensity of the solar rays without changing their parallelism. M. Bertsch has proposed an arrangement intended to effect this object, consisting of a convex lens, on which the solar rays fall, forming an image of the sun in its focus. Between the lens and focus, however, a small concave lens is interposed, in such a position that the convergent rays, after passing through the second lens, emerge parallel and concentrated. A similar effect may be obtained by having a small convex lens of short focus placed beyond the focus of the larger lens. M. Van Monkhoven argues that although an apparatus of this kind would be applicable to light issuing from a luminous point at an infinite distance off, the instrument is inapplicable to sun-light, because this body has a sensible diameter; and since the image formed at the focus of the larger lens would be necessarily of greater diameter than that formed by the other at its focus, no condensation can possibly take place. To this argument M. Bertsch replies, that he has made the instrument, and it does answer; and that as the angles of the pencils of rays proceeding from the sun never exceed half a degree, they are so small that they may be neglected.

We have already * called attention to some researches by M. G. Quincke, on the optical properties of the metals, in which he showed that their refractive indices were less than unity; in a second memoir by the same author on this subject, the theory is followed out mathematically as well as experimentally, and the further discovery is announced that the refractive index of the metals is dependent upon the angle of incidence and increases with an increasing angle.

When a luminous body is viewed through some kinds of transparent minerals, such as certain varieties of mica, rays of light are seen to diverge from the luminous centre, at equal distances apart. This appearance has received the name of *asterism*. A method of producing asterism artificially, in a manner as clear and perfect as is met with in some of the naturally-occurring minerals, has lately been published by M. C. A. Grüel,† of Berlin. A clear piece of plate-glass is cut in the form of an equilateral triangle, with sides measuring 1½ to 2 inches. The surface of this triangle is then rubbed backwards and forwards a few times on a sheet of fine emery-paper; each of the three sides being successively guided against a metal rule, which at the same time being pressed on the emery-paper, keeps it in position.

* 'Quarterly Journal of Science,' vol. i. p. 342.
† 'Phil. Mag,' series iv. vol. xxvii. p. 400.

The feeble striping of the glass surface thus obtained produces accurately the condition of a series of lines crossing at an angle of 60°, which is fulfilled by the similarly directed edges of the groups of microscopic crystals observed in some kinds of mica, &c. By cutting the glass to the shape of any other regular sided figure, and rubbing it with emery-paper in directions parallel to the different sides, an eight-, ten-, or multi-fold star will be produced, according to the angle under which the series of lines cross. These are best observed by holding the glass near the eye, and looking at a fine hole in a plate of metal behind which a candle-flame is placed.

A new analysis of Fraünhofer's line **D** has lately been communicated to the Royal Society by Mr. Gassiot. The spectroscope with which it was performed was made by Browning, and is, without doubt, the most magnificent instrument of the kind which has ever left the workshops of that optician. The train consists of no less than eleven bisulphide of carbon prisms, the sides of which are prepared by Professor Cooke's method, so as to remedy the curvature of the glass-plate from the hardening of the glue. On examining the double line **D**, after passing through this train, it was found that its two components were separated 3'6", and that there was a third line exactly equidistant between them, together with other lines, filling up the intermediate space. But the most remarkable circumstance was, that the two dark lines composing the double line, were themselves each split up into three lines, the centre one being the thickest. It is intended to examine other parts of the spectrum with this apparatus, and there is no doubt that very valuable results will be obtained from such an extended investigation.

Spectrum analysis is not only applicable to the detection of metallic elements. By a slight modification of the apparatus, this powerful agent may be applied to the discrimination of a vast number of organic bodies; hitherto, however, this branch of the subject seems to have been unaccountably neglected, Professor Stokes being almost the only person who has assiduously devoted himself to the subject. One of the most recent results at which he has arrived is likely to be of considerable practical importance. He has submitted blood to searching spectrum analysis, both before and after treatment with different chemical re-agents. This liquid exhibits two well-marked dark bands in the yellow and green. These were first noticed by Hoppe, and are eminently characteristic of blood. The addition of an alkaline solution of copper to this fluid still shows these characteristic bands, although to the eye the colour is quite changed. On adding, on the other hand, acetic acid to a solution of blood, the colour was very slightly changed, but the bands had entirely disappeared. A comparison of these bands with those given by some iron salts, negative the supposition that the colour of blood is due to a salt of iron, as such, even had we no other means of deciding.

In a note by M. Marignac, on silico-tungstic acid, he describes a remarkable series of compounds, most of their properties, however,

belonging more to the domain of chemistry than optics; one compound, the silico-tungstate of soda, is likely to be of great use in the manufacture of fluid prisms, inasmuch as a solution can be obtained having the specific gravity of 3·05, and being very fluid, but on which glass, quartz, and most stones will float. If its refracting powers are equal to its density, this solution will be invaluable for fluid prisms. We may also mention that a compound of thallium with the elements of alcohol, ethylate of thallium, has also been proposed for the construction of fluid prisms. It is a heavy, oily liquid, of about the density and refracting power of bisulphide of carbon, but unlike the latter liquid, non-volatile.

A most ingenious application of scientific principles to the illumination of theatres has just been carried out by M. Soubra. The footlights in front of the stage of a theatre are almost invariably argand burners, surrounded by glass; not only is there very great danger of the thin dresses worn by the actresses taking fire, but the products of combustion vitiate the atmosphere of the stage, whilst the heated air rising from them just across the line of sight of the spectators in the stalls, renders the view from these seats less pleasant than it would otherwise be. The reason why the flame of an argand burner, or any any other light, points upwards, is owing to the heated air and products of combustion being lighter than cold air; the former, therefore, rise upwards, and cause the flame to rise also. If, however, a downward movement could be impressed upon the heated products of combustion, the flame would equally well follow the same direction, and would continue to burn downwards. M. Soubra, therefore, takes a wide glass pipe, bent in the form of the letter **U**; one leg, however, being considerably longer than the other one. Just inside the shorter leg of the two, an argand burner is inverted, and the longer leg of the tube being heated for a short time, so as to rarefy the air in it, and cause a downward current in the short end, the argand burner is lighted, and the flame, following the direction of the current of air with which it is surrounded, continues to burn upside down—the current once established being sustained by the heat from the inverted flame. The advantages from this new arrangement are as follows:—The supports of the globes, or lamp-glasses, are placed above the flame, and do not intercept the light; the reflectors also are in no danger of becoming blackened by smoke, and they collect rays that would otherwise be lost in the air; the flame has a more elevated temperature, on account of the heat being concentrated by the syphon, and the carbon is consequently rendered more incandescent; the products of combustion may easily be carried away through the longer leg of the tube into a chimney, instead of vitiating the air of the apartments. The advantages as to safety, &c., of this plan are so obvious, that no time should be lost in introducing this method of illumination in this country. It is, we understand, already adopted in France with great success.

Many years ago Mr. Fox Talbot discovered that when a continuous spectrum is examined by covering one-half of the pupil of the eye

with a thin transparent plate, so as to modify that part of the pencil of rays on the side of the violet part of the spectrum, a number of transverse bands, alternately light and dark, appear to traverse it. Brewster discovered that these bands were not formed when the thin plate was placed on the side of the spectrum corresponding with the red rays. It has since been discovered that these bands may be produced by interposing the thin plate in other portions of the path of the ray, besides putting it close to the eye. Baden Powell, and Stokes have since studied the phenomena both experimentally and theoretically, and the latter physicist found that the effects were best produced by the partial immersion of a transparent plate in the liquid of a fluid prism. M. Bernard has lately studied these phenomena, and has arranged his apparatus in the following manner:—A ray of solar light passing through a narrow orifice falls on the slit of a spectroscope, the defringent plate being then placed between the aperture admitting the light and the slit of the spectroscope, and some adjustments and arrangements are made, into the detail of which we need not enter. In this manner M. Bernard is enabled to obtain a very luminous spectrum, and he has been led by an examination of the phenomena to the discovery, that through them he is enabled to obtain the length of the waves of any desired ray of light or spectrum line with much greater accuracy than by the ordinary diffraction method. In his memoir he has given the wave lengths of the seven principal rays of the solar spectrum, together with that of the ray **A**, which, owing to its faintness, has not yet been satisfactorily determined, and the green ray of thallium. Their values, expressed in millionths of a millimetre, are—

A = 760·6
Tl = 535·2 *

The diffringent plate of quartz is about a millimetre thick, and its thickness can be determined with absolute accuracy with the spherometer; and when it is remembered that between **A** and **H** there are for this thickness more than 700 interference bands, and that it is easy to estimate to the tenth of a band, it is seen that there are more than 7,000 invariable points in this portion of the solar spectrum, and it is by reference to these that M. Bernard proposes to classify the rays of the alkaline metals and other interesting spectra. For this purpose he has constructed an apparatus which acts both as a spectroscope and a goniometer, and which enables the observer to measure to within 10″, the indices, a knowledge of which is necessary to calculate the wave lengths.

Heat.—Some important results have been communicated to the Berlin Academy by M. Hagen,† respecting the heat of the sun's rays. He has come to the conclusion that the heating effect produced by the sun's rays on entering this atmosphere may be expressed by say-

* Dr. J. Müller ('Quarterly Journal of Science,' vol. i. p. 157) finds the length of the wave of the green thallium line to be 534·8 millionths of a millimetre.

† 'Phil. Mag.,' ser. iv. vol. xxvii. p. 478.

ing that a bundle of rays having a section of a square inch, would in one minute raise the temperature of a cubic inch of water by 0·733 of a degree centigrade. On comparing these results with those of Pouillet, it is seen that the latter observer found the heat of the sun's rays to be one-eighth less. Pouillet, however, assumed that the height of the earth's atmosphere was equal to the 80th part of the earth's radius, whilst M. Hagen finds that the height of the atmosphere, assuming that the layers of air have the same power of absorption, is only equal to the 173rd part of the earth's radius.

In his remarkable work on heat considered as a mode of motion, Dr. Tyndall observed that it would be interesting to see whether the balls of rifled guns would not show signs of fusion. M. Schrœder remarks, that, by having a ball constructed of zinc, he thinks it would be possible to estimate the amount of heat given out on striking the target. He finds that at a temperature above boiling water zinc becomes granular, and that if the heat is very gradually increased, the metal will, without losing its form, assume exactly the appearance of zinc that has been melted. It is not unlikely that an experiment with this metal might furnish some information, but the determinations of temperature would not be very accurate, and it would probably be possible to discover a more certain way of estimating the heat given out by the concussion; at the same time the suggestion is useful in the absence of a better measure of temperature under the conditions of the experiment.

Dr. Tyndall has been for some time past engaged in some investigations on the non-luminous heat-rays of the spectrum with reference to their deportment towards certain bodies which are perfectly opaque to light. He has found that a solution of iodine in bisulphide of carbon entirely intercepts the light of the most brilliant flames, whilst to the ultra red rays of the spectrum the same solution is perfectly diathermic. If a hollow prism is filled with this opaque liquid and placed in the path of the beam from an electric lamp, the light-spectrum will be completely intercepted, whilst the heat-spectrum passes through, and can be examined by a thermo-electric pile. A liquid of this kind, which will allow physicists to sift the heat-rays from the light-rays, will be of great value in many experiments in physical optics. Indeed, the discoverer is not the person to allow such a valuable adjunct to experiment to remain idle in his hands.

It has long been known that heat weakens or destroys the magnetic force in permanent magnets, but we are not aware that any very accurate researches have been made on this subject. M. Mauritius has lately published* some results, in which he shows that when a permanent magnet is alternately exposed to the temperatures 100° C. and 0° C., the magnetism ultimately becomes sensibly constant on the return of the same temperature. It is now found that when the magnetism at 0° and then the magnetism at 100° are measured, a diminution takes place at the higher temperature and a corresponding

* 'Bibliothèque Universelle de Genève,' March, 1864.

increase at the lower temperature, and that the diminution of the magnetic force from 0° to 100° is proportional to its magnetism at 0°. With regard to temporary magnetism induced in soft iron, cast-iron, and steel bars by means of an electro-magnetic coil, it was found that at a bright red heat none of the bars were magnetic. Approximate determinations of the descending temperature at which magnetism begins to be manifested gave 1,000°. With the steel bar the increase of magnetic power takes place at first very rapidly, then for a certain time it goes on slowly, and then again follows a period of rapid augmentation. With the cast-iron bars the second period of rapid increase is also observed, but in a less marked degree; but with the wrought-iron it does not exist. The author believes he may conclude from his experiments that the magnetic properties of iron are developed suddenly at a determinate temperature.

ELECTRICITY.—A very valuable instrument for the production of a constant stream of electricity has been for some months past exhibited in the scientific circles of London. It is an electro-magnetic induction machine, but unlike ordinary machines of this kind the stream is constant in one direction, and it can be produced of any tension or quantity that may be required. Many attempts have been made to use induced electricity for telegraphy, but they have generally failed because the tension of the current is too great, and the electricity is in impulses. What has long been wanted is as near an approach to a battery current as possible, and of any required tension or quantity without multiplying the number of battery cells used. The machine must also be perfectly self-acting. The way in which these desiderata are effected in the machine now alluded to is by using two series of induction coils, which are so arranged that one is being magnetized nearly at the same time that the magnetism is subsiding in the other, so that the two induced impulses may be said to overlap each other; and though these are in opposite directions, the spools are so arranged that in the general induction circuit they flow in the same direction, thus making a compound impulse of longer duration, composed of the two opposite inductions. Such a compound impulse is produced from each induction coil, and by an ingenious arrangement of the commutator, they are all turned into one direction, producing a slightly undulating but continuous flow. The machine is made for quantity, the inner coils being of number 12 wire, and the outer of number 18. To an electrician the very name induction coil speaks danger, as it conjures up visions of powerful sparks, many inches long, darting from pole to pole, and capable of piercing through considerable thicknesses of gutta-percha, or even glass. Experiments have, however, shown that such fears are groundless with an instrument of this construction; the two wires may be brought so close together that a considerable magnifying power is required to show that there is any space at all between them, before a spark will bridge across the interval, and it is then of the feeblest and most innocent description, being unaccompanied with noise and scarcely visible in daylight. The striking distance is less than the thousandth of an inch.

Whilst the electrical relations of metals, &c., in aqueous solutions of acids, alkalies, and salts, have been repeatedly, and we may almost say exhaustively examined, few, if any, experiments have been made on the similar relations in fused substances. This gap has now been filled up by Mr. Gore,* who has examined the electrical relations of carbon, magnesium, aluminium, silicium, zinc, tin, lead, iron, nickel, copper, silver, gold, and platinum, in sixty-seven salts or mixtures of salts kept in a state of fusion, in small porcelain crucibles, either by an ordinary Bunsen burner, or when difficultly fusible, by one of his small gas furnaces already described in this Journal. The results are carefully tabulated, and amongst others it is found that the most negative substances in fused salts are generally platinum, gold, carbon, and silver; the most positive substances are generally magnesium, aluminium, and zinc. Silicium is generally electro-positive to carbon, and is strongly positive, and quickly corroded in fused alkalies, alkaline carbonates or fluorides. Carbon is not generally very positive to iron. This investigation throws some light upon the desirable object of obtaining a cheap source of electricity by the combustion of coke or gas carbon. The discovery of some suitable fused salt or mixture, in which carbon is highly electro-positive at a high temperature to iron, nickel, or other infusible and suitable conductor would probably prove a cheap and powerful source of electricity: cheap, because of the low equivalent number of carbon, and the low price of coke and gas carbon; and powerful, because of the intense affinity of carbon for oxygen at high temperatures,—an affinity sufficient, indeed, to set the alkali metals free from their oxides. The nearest approach in these experiments to this object was with carbon and nickel in a fused mixture of soda, lime, and silica.

Many experimentalists have examined the stratified light of the electric discharge, and have assigned various causes for this curious phenomenon; they seem, however, all to have ended in the establishment of one fact only, that the alternate light and dark bands require for their production an imperfect conductor. M. L'Abbé Laborde † has lately succeeded in producing an analogous stratified appearance, and permanently fixing it on a plate of glass. For this purpose he prepares a glass plate with iodized collodion, and then lets it undergo all the operations customary in preparing a photographic image. It is exposed for a brief time to light, and then the silver is reduced by a developing agent. A surface is thus obtained which possesses an intermediate conductibility. The two ends of the induction wire being placed a little distance apart on the surface, the spark will produce stratification in passing from one to the other. A suitable surface cannot invariably be obtained; when the plate presents the appearance known as solarization, and has a reddish transparent tint, the surface is not sufficiently conducting, and the spark passes over without attacking it. If on the contrary the silver is completely reduced, and presents a metallic and mirror like layer, it conducts too well, and the

* 'Chemical News,' June 4, 1864.
† 'Comptes Rendus,' lviii. 661.

spark traverses without modifying it. Between these two extremes, surfaces are obtained on which the spark produces more or less complete stratification of very varied appearance. The designs traced by the electric current are transparent on an opaque surface, so that they can be copied directly on positive photographic paper.

It has not hitherto been possible to obtain a deflection of the magnetic needle by the secondary current of the Leyden battery, but by means of an apparatus which he calls the "electrical valve," M. P. Riess* has succeeded in obtaining evidence of this deflection, and has deduced the convenient rule that by means of the electrical valve, and in any position, the secondary current of the Leyden jar deflects a magnetic needle in the direction of a current proceeding from the disc to the point of the valve. M. Reiss describes a numerous series of experiments which show in a very striking manner the occurrence of the extra current in the circuit of the battery itself, and are not less conclusive than are the previous experiments of the author on the heating of the branches.

X. SANITARY SCIENCE.

That the weather exercises a considerable influence over the health of individuals and communities has long been a favourite article in the popular creed, and this belief has been embodied in many a wise saw and pithy proverb. But it is not only in such apophthegms that this conviction of the influence of the weather upon disease and mortality has been expressed; it has formed the subject of many laborious and learned memoirs, and since the time when Hippocrates penned his celebrated treatise 'On Airs, Waters, and Places,' it has taken a permanent position in the medical literature of all civilized lands. In more modern times the researches of Casper, Quêtelet, Boudin, Guy, Sir James Clark, and many others, have done much to throw light upon the effects produced by external causes on the constitution of the human frame. During the past year, the literature of this subject has received an addition, in the form of an elaborate memoir 'On the Influence of Weather upon Disease and Mortality,'† by Dr. R. E. Scoresby-Jackson, in which an endeavour is made to treat the subject in a somewhat more exact manner than has often been attempted. His investigations are restricted to the climate and death-rate in the eight principal towns in Scotland, and the data he has employed in the course of his inquiry have been furnished by the collected returns from the stations of the Meteorological Society of Scotland, and from the mortality tables constructed from the returns made by the Scottish Registrar-General. The period over which his investigations have extended is six years. At the outset of his memoir he lays down the following proposition, one, we think, to which

* 'Phil. Mag.,' series iv. p. 313.

† Transactions of the Royal Society of Edinburgh, 1863, and reprint.

sufficient attention is not at all times given :—"We are not to assume that because certain conditions of weather, as indicated by meteorological instruments in this country, are opposed to recovery from certain diseases, that therefore patients so suffering are not to be sent into any country where meteorological instruments afford exactly, or even nearly, parallel readings. In other words, in estimating the value of a foreign climate, or the different climates of our own country, we are not to depend so much upon a comparison of the meteorological data of the several places, as upon the meteorological data and the prevalent diseases and death-rate of one and the same locality. To argue that because a given condition of temperature, atmospheric pressure, and humidity, in Scotland, is accompanied by a certain ratio of mortality, therefore, meteorological data being equal, the same death-rate will be observable in Torquay or Madeira, would be most fallacious. All other things being equal, the death-rate would also coincide, but it requires much more than mere meteorological analogy to establish such a parallelism." From the materials employed by the author, the conclusions he has arrived at are to be regarded as applicable only to those localities in Scotland from which his data were obtained. With regard to the influence of temperature on mortality, he concludes that the relationship between mortality from all causes and mean temperature is inverse when the mean is below 50°, and direct when the temperature is higher, *i.e.* the relationship is inverse in winter, spring, and autumn, but direct in summer. Again a low winter temperature increases the mortality from phthisis pulmonalis, especially when it is very and continuously low, and both with it and bronchitis the relationship between mean temperature and death-rate is inverse all the year round. A high mean summer temperature increases infantile mortality. But in all statistical inquiries into the influence of temperature on mortality, in which the deaths occurring during a given period are compared with the temperature of the same period, it should never be forgotten that cold and heat do not necessarily act immediately, but that the diseases engendered or aggravated by them must run their course, and the deaths arising therefrom may be registered at a time when the thermometric scale exhibits a very different mean from that which it presented when the disease originated.

Again, the prevailing opinion that northerly winds act injuriously on health is confirmed by Dr. Jackson's tables, for a high death-rate attends winds blowing from a point between N.W. and S.E. (north about), whilst winds blowing from a point between S.E. and W. (south about) occur more frequently during months in which the mortality from all causes is low.

Many other interesting relations are suggested by the tables and diagrams with which the memoir is copiously illustrated, such as the relationship between the barometric pressure and the death-rate, and the influence of drought and humidity on mortality. But for an account of the results indicated or arrived at we must refer our readers to the original memoir itself.

Since the year 1851, when Schönbein communicated to the Medico-Chirurgical Society of London a memoir, in which he pointed out that the inhalation of ozonized air occasioned a painful affection of the chest,—a sort of asthma,—accompanied with a violent cough, the attention of the medico-meteorologist has been directed to the determination of the proportion of ozone in the atmosphere, and its relation, if any, to the prevalent diseases of the time or of the place.* Both in this country and in Germany careful registers have been kept of the variations in the amount of atmospheric ozone during a number of years. But we cannot as yet say that any very trustworthy results have been arrived at, as to the relations between its excess and deficiency, and the diseases which may have been most rife during the same period. This indefinite condition of the question may perhaps be in part explained by the somewhat inexact nature of the test employed. For, although the ozone papers may be sufficiently delicate to indicate absolute deficiency or excess of atmospheric ozone, yet the determination of minute shades of difference will vary much with the individual observer, with his power of appreciating the exact tint produced on his test paper, and of referring it to the corresponding shade on his reference paper. And it is, perhaps, to the difficulties which exist in comparing the results obtained by observers stationed in different localities, that we must, in some measure, ascribe the very different statements which have been made of its action on the animal frame. For whilst one set of observers declares that there is a remarkable coincidence between an excess in the amount of atmospheric ozone and the prevalence of affections of the respiratory passages,† on the other hand, M. de Piétra Santa ‡ states that at Algiers, where bronchial affections are rare, ozone exists abundantly in the atmosphere.

Again, the attempts which were at one time made to show that diseases of the alimentary canal, and even cholera, were more rife when the proportion of ozone in the air was small, have not been borne out by subsequent investigators.

More exact results of the power of ozone when in excess, to act upon the human frame may, however, be obtained by direct experiment, as when air is artificially ozonized, and animals are compelled to breathe it for a given period. This line of inquiry has now been followed out by various experimenters. Schönbein,§ Schwarzenbach,‖

* References to the following papers on the subject may prove useful to some of our readers :—

Spengler. Influenza und Ozon. Henle u. Pfs. Zeitschrift, vii. 1. 1848.

Heidenreich. Ozon und Katarrh. Neue med. chir. Ztg. vii. 3.

Clemens. Wirkungen Ozonzerst : Gase auf den Mensch : Organismus. Henle. u. Pfs. Zeitschrift, vii. 2. 1848.

Annales d'Hygiène publique. Paris. 1863. P. 439.

† This side of the question has been very recently advocated by Dr. Hjaltelin, of Reikjavik, in an able paper on "Epidemic Pneumonia in Iceland," in the year 1863, published in the 'Edinburgh Medical Journal,' May, 1864.

‡ 'L'Union Médicale,' 30 Mai, 1861.

§ Henle und Pfs. Zeitschrift. N. F. Bd. 1. S. 384.

‖ Canstatt's Jahrb. 1851. 1, 128.

Böckel,* and Desplats,† have all confined animals in air, ozonized either by means of phosphorus or by passing electric sparks through it. In every case, the animals died with symptoms of affection of the respiratory organs, though Schwarzenbach thinks that the nervous system, and more especially the *nervus vagus*, was also involved. During the past year, another series of experiments has been recorded by Dr. W. Ireland,‡ from which he has been led to form the following conclusions:—

1st. Ozonized air accelerates the respiration, and, we may infer, the circulation also.

2nd. Ozonized air excites the nervous system.

3rd. Ozonized air promotes the coagulability of the blood, probably by increasing its fibrine. In the blood, however, ozone loses its peculiar properties, probably entering into combination with some of the constituents of the circulating fluid.

4th. Animals can be subjected to the influence of a considerable proportion of ozone in the air for hours, without permanent injury; but in the end, ozone produces effects which may continue after its withdrawal, and destroy life. In ozonizing the air for his experiments, Dr. Ireland pursued a plan differing from that adopted by his predecessors. He introduced sulphuric acid and permanganate of potash into a glass bottle, and collected the ozonized air, produced by their action on each other, in a glass jar under water. This method seems to present decided advantages over the plan commonly pursued, of burning phosphorus in air. For in this latter process, not only are fumes of phosphoric acid generated, which it is not very easy to get rid of, but a part of the oxygen of the air is consumed in the combustion, and its proportion to the nitrogen, therefore, necessarily diminished.

Whilst on the subject of ozone, we may notice some recent experiments by A. Schmidt,§ which seem to show that ozone, or a substance capable of producing it, exists in the blood. Instead of employing iodide of potassium as the reagent for the ozone determination, he used strips of paper soaked in a tincture of guaiacum (1 part wood to 6 parts alcohol), and when the alcohol had evaporated, a drop of blood was added to the paper. A blue ring appeared in the course of a few minutes, where the layer of blood was the thinnest. The depth of colour of the ring varied with the blood employed: with that of the ox and horse it was the strongest; with that of man, without the addition of water, feeble; and with birds' blood, not at all, until after the addition of water, and then strongly. Pure colourless serum did not act at all. Schmidt considers the hæmatin of the blood-corpuscles to be the ozone-producing material. He also noticed the oxidizing action of the blood-corpuscles on a solution of indigo. Schmidt concludes that in the blood a quantity of oxygen ready to become ozone

* Thèses de Strasbourg, 1856.
† Thèses de Paris. 1857.
‡ 'Edinburgh Monthly Medical Journal,' February, 1863.
§ Ueber Ozon im Blute. Dorpat. 1862.

exists. When putrid, the blood lost its power of affecting reagents, though four weeks after having been drawn, it was not quite inactive.

Before closing our chronicle, we may direct attention to the report by Messrs. Hewlett, Stanley, and Reed, on the ventilation of the new barracks, at Gravesend, contained in the recently-issued statistical sanitary and medical reports for the Army Medical Department.* The observations made by these gentlemen show the importance of attending to the organic impurities floating in the atmosphere, and they bear out in many respects the conclusions arrived at by Pouchet and others. The method they employed was to draw the air, by means of an aspirator, through a solution of permanganate of potash, of known strength. The liquid became discoloured during the experiment, and a deposit occurred. This deposit was examined microscopically and found to contain fragments of epithelium, pus-cells, pieces of cotton fibre, shreds of wool, and large numbers of amorphous bodies. Dr. Parkes, in his remarks on these and other allied observations, points out that they put in a clearer light than before the necessity of ventilation, and the advantage of isolating patients, from whose bodies arise such quantities of organic particles. They would also seem likely to put on an experimental basis the doctrine of the transference of morbific agents from one person to another. The volume contains, besides, a large amount of very instructive matter, not only as regards the health of the British Army, but on sanitary questions generally.

XI. ZOOLOGY AND PHYSIOLOGY.

(*Including Proceedings of the Zoological Society of London.*)

The two topics which have received the greatest attention during the past quarter are the discoveries of M. Lartet, respecting the co-existence of man and the reindeer in central France, and the theory of Dr. Hunt as to the Negro's place in nature. The former subject comes perhaps more strictly within the range of the palæontologist, still it will not be out of place here to mention, that seventeen stations have been discovered in France where the presence of the reindeer has been ascertained in a state of subjection to man; but as to the epoch when the reindeer ceased to inhabit what is now temperate Europe, there is no positive historical or chronological account. Its remains are not even found in the French turbaries, nor in the Swiss lacustrine pile-works; but remains are found in a cave of Mont Salève, in which they are associated with simply worked flints; and in the grottoes of Perigord are found flint flakes, and utensils and weapons manufactured of the horns and bones of the reindeer.†

* London, 1863.

† A very interesting account of these remains, accompanied by illustrations, will be found in the letter of our Paris correspondent. ("Notes and Correspondence.")

With regard to Dr. Hunt's views of the Negro's place in nature, his paper proposed to show, that in the proportions of the arm, the form of the hips, thighs and fingers, the flatness of the foot, and the size of the molar teeth, there appeared a nearer approach to the ape than was seen in the European. The brain was comparatively small, the facial angle low, and all development of the brain ceased at puberty, while the form of the skull became more ape-like as he advanced in years. The structure of the brain was distinct from that of any other race of man; and it had yet to be established whether the offspring of the European and Negro were indefinitely prolific. There was not a single instance of a pure Negro being eminent in science, literature, or art; and Dr. Hunt concluded from all his observations, that there was as good reason for classifying the Negro as a distinct species from the European, as there is for making the ass a distinct species from the zebra,—that the analogies are far more numerous between the Negro and apes, than between the European and apes—that the Negro is inferior, intellectually, to the European—that the Negro is more humanized when he is in his natural subordination to the European than under any other circumstances—that the Negro, indeed, can only be humanized and civilized by Europeans, and that European civilization is not suited to the requirements and character of the Negro.

These premises evoked a considerable amount of discussion at the time the address was delivered, in which, although some were decidedly opposed to the whole theory, the balance of opinion appeared to be in Dr. Hunt's favour. Subsequently, Professor Huxley, in his Hunterian lecture, alluded to the paper for the purpose of condemning it, which called forth a paper war in the columns of the 'Reader,' between Dr. Hunt, Mr. C. Carter Blake, and Professor Huxley. This discussion, however, which promised to be a very acrimonious one, and was not carried on with the most desirable courtesy, was nipped in the bud by the reticence of the Professor, who having had his word, let the matter drop, and returned no response to the replies of the leaders of the Anthropological Society.

M. Gratiolet has been discoursing upon Man's place in nature, and his remarks are, of course, worthy of great attention. Speaking of the brain of the apes, he says: "There is an enormous posterior cornu with lateral ventricles, and it occupies all the interior of the posterior lobes of the hemispheres. This fact has been denied by Professor Owen, but his error is obvious." He goes on to observe that the encephalon of man and that of the apes present a typical resemblance, and this resemblance is exclusive—man resembles the apes and the apes only. All the differences relate to secondary characteristics—the volume, complication, and reciprocal proportions of the parts. But at no epoch is the human brain, typically so like an ape's brain, actually an ape's brain.* One can make of material man neither a kingdom, a division, a class, an order, nor a family of an order. He is apart from the beings which most resemble him. He also compares *the hand* of the ape and man. In the former, in reality, the hand is free only when the animal is at rest, and this liberty

reduces itself to the movements of brutish prehension. What a difference is there in the hand of man! From a simple prehensile organ it becomes a measuring instrument—from a hook it becomes a compass, and the compass presupposes the geometrician. With regard to the disputed question of the *Negro's* place in nature, M. Gratiolet exclaims—"Do these races (*i. e.* the Negroes and certain other degraded races) form a passage between man and the apes? No—a thousand times No! Their deformity even protests against such an assertion. Far from dwindling down, the human characteristics become more decided, and even exaggerated in their case. The lobe of the ear, the nostrils, the lips, which are the exclusive character of man, are developed even to deformity. Everything in the Negro's degraded face protests against this impious assertion."

The Society of Arts and Sciences of Utrecht has propounded some questions for which it is proposed to give prizes, *viz.* for each a gold medal, value 300 Dutch florins. The following relate to the subjects under consideration:—1. Observations on the influence exerted by small variations of exterior circumstances upon the evolution of the embryo of one or more species of vertebrate animals. 2. Chemical and physiological observations on the digestion of freshwater fish. 3. Chemical and physiological observations on the digestion of reptiles. 4. It has long been known that fish have the faculty of producing sounds; the Society requires observations on the manner in which the sound is produced in one or more species where the cause has not yet been pointed out. 5. Observations upon the development of one or more species of invertebrate animals, the history of which is not yet known, accompanied by the figures necessary to explain the text. The successful essays will be published in the memoirs of the Society, and all replies must be sent to the Secretary, Professor O. Van Rees, Utrecht, before the 30th November next.

In a paper by Dr. W. H. Dickinson, read before the Royal Society, upon the Functions of the Cerebellum, he infers from numerous experiments upon the lower animals, that the cerebellum has nothing to do with cranium sensations, with the sexual propensity, with the action of the involuntary muscles, with the maintenance of animal heat, or with secretion; but the only function which his experiments seemed to assign to it was such as concerns voluntary muscles, which receive from it a regulated supply of motor influence. Each lateral half affects both sides, but the one opposite to itself the most. The anterior limbs are chiefly under the influence of the cerebrum; the posterior, of the cerebellum. Cerebellar movements are apt to become habitual, while cerebral are impulsive. In the human subject, the only faculty which constantly suffers in consequence of changes in the cerebellum is the power of voluntary motion. When congenitally defective, there is want of action in the muscles of the lower extremities. The occasional occurrence of loss of visual power, and alterations of the sexual propensity in diseases of the cerebellum, are referred to the conveyance of irritation to the *corpora quadrigemina* in the one case, and to the spinal cord in the other. From all

experiments on animals and on man, it is concluded that the cerebellum is a source of voluntary power to the muscles supplied by the spinal nerves. It influences the lower more than the upper limbs, and produces habitual rather than impulsive movements—and it has a power, which has been described as that of *co-ordination*—and it is suggested that the outer portion of the organs may be the source of its voluntary motive power, while its inner layer is the means of regulating its distribution.

Mr. Rowley, of Brighton, has recently added to his collection the only egg of the *Æpyornis maximus* which ever came to this country, and has in a shilling pamphlet, published by Trübner and Co. (and noticed amongst our reviews), made some interesting observations, not only on the unique zoological specimen, but upon the bird which laid it.

G. O. Sars, son of the celebrated Norwegian Professor, has been dredging in freshwater lakes in Norway, and has met with some curious confirmations of former observations, that true inhabitants of the sea can, under certain circumstances, gradually accustom themselves to live in thoroughly fresh water. The conditions of change, as exhibited in some Swedish lakes to Professor Lovén, may be very gradual, operating throughout thousands of years, but, in the present instance, it must have been much shorter. Sars found in the mud at the bottom of this lake a small red crustacean, in which he at once recognized a saltwater species, although the water was perfectly fresh and pleasant to the taste. In the case of this lake, apparently some very high flood, or a furious storm from the west, has driven the sea up on some occasion into the loch, which lies close to the coast. Their residence in a foreign medium, however, appeared to have changed the mode of life of these animals, for, instead of being found as usual in the shallowest pools, they were here in the deepest part of the water, sunk in the mud. Dredging in Mjösen Lake, which flows through a large river, he discovered a crustacean, *Mysis relicta*, of Lovén, belonging exclusively to salt-water; one of those extraordinary relics of the glacial period, whose presence in some of the great inland lakes of Sweden has lately excited so much interest. Associated with it were numerous examples of a Gammarus (*G. cancelloides*), first discovered in the seas of Baikal and Angora, and which has lately also been found in Sweden, and which Lovén considers originally to have belonged to the sea.

These observations of Lovén and Sars may tend to modify materially certain geological theories.

A valuable and interesting paper has been communicated to the Linnæan Society by Mr. A. R. Wallace, on the 'Phenomena of Variation and Geographical Distribution as exhibited by the Malayan Papilionidæ.' The large butterflies of this region are well adapted for this purpose, since their gaily-painted wings register the minutest changes of organization, and exhibit on an enlarged scale the effects of the climatal and organic conditions which have influenced more or less profoundly the organization of every living being. The variations occurring among the 120 species inhabiting the Malayan Archipelago are classed by Mr. Wallace under the heads of, 1st, simple variability;

2nd, dimorphism or polymorphism; 3rd, local forms; 4th, coexisting varieties; 5th, races or sub-species; and, 6th, true species. The first includes all great instability of specific form; the second, polymorphism or dimorphism, differs from the first in this—that the offspring differs from the parents in a considerable degree, and in a manner more or less constant and regular—so that, of the offspring of a single pair, some will resemble their parents, while others will differ from them, but the difference will be tolerably fixed and definite, and intermediate varieties will never occur. He explained how such a state of things came about in a Philippine island butterfly, *Papilio alphenor*. But the most interesting portion of his observations was directed to the subject of variation as specially influenced by locality, for example, the fact that the species of this Indian region (Sumatra, Java, &c.) are almost invariably smaller than the allied species of Celebes and the Moluccas. The most remarkable of these cases was that of the island of Celebes, almost all the Papilionidæ, Pieridæ, and some of the Nymphalidæ of which had acquired a peculiar curve of the upper wings, amounting in some instances to an abrupt bend. If, he argues, the butterflies of the Celebes acquired their longer and more curved wings owing to the persecution of bird or insect enemies, from which they could only escape by increased powers of flight, it is evident that those which had already some other means of protection would receive no benefit from a change in the form of their wings, and therefore could not acquire it by the action of *natural selection*. This also explains why none of the Danaidæ are so modified, for they are universally the objects of mimicry by other groups, and are therefore already protected. These Danaidæ are a nuisance to the collector from their abundance and ubiquity, and their strong and peculiar odour is believed to be the cause of their safety, and they are, for this reason, habitually passed over by insectivorous creatures. Mr. Wallace, therefore, with Mr. Bates, argues that mimicry is in all these instances a means of protection.

In a discussion which recently took place in the Entomological Society with reference to the luminosity of fire-flies, Mr. Bates remarked that the Honduras fire-fly (*Fulgora lanternaria*) was pretty common in the upper Amazons, but he had never found it luminous; moreover, although the creature figured in their fables, and was reputed to be poisonous, there was no rumour current among the natives of its being luminous.

M. Siebold has communicated to the Helvetic Society of Natural Sciences a curious fact of parthenogenesis of bees. A hive at Constance furnished for four years a considerable number of hermaphrodite bees, which immediately after their hatching are expelled from the hive by the workers. None of these individuals resemble one another; sometimes one side is male and the other female, or the anterior parts (head, eyes, antennæ, &c.) are of one sex, while the posterior belong to the other; while sometimes the internal apparatus belongs to one sex and the external to the other. Some individuals are, in the interior, males on the right side and females on the left, while the reverse is the case on the exterior. The eggs from

which these hermaphrodites issue, are laid in the workers' cells, and ought, therefore, to become workers, but the queen-bee, having probably some defect in organization, a part of these eggs are only incompletely fecundated, so that the development of the female organs remains in a more or less rudimentary condition.

The cultivation of silkworms is so important a branch of industry in some portions of the globe, that any information respecting their diseases and modes of cure becomes highly valuable. Captain Hutton, F.G.S., of Mussooree, N.W. India, attributed the enormous loss of worms by "muscardine" and other diseases to the combined effects of bad and scanty food, want of sufficient light and ventilation, too high a temperature, and the constant interbreeding for centuries of a debilitated stock. He regards, after long experience, the occasional occurrence in a brood of one or more dark grey or blackish brindled worms, —the *vers tigrés*, or *vers zébrés*—as an attempted return, on the part of nature, to the original colours and characteristics of the species; in fact, the dark worms, hitherto rejected by the sericulturist, were the original and natural worms, and the whiteness or pale sickly hue of the majority was a positive indication of degeneracy and the destruction of the original constitution. He recommends the sericulturist to separate his dark worms from the general stock, and to set them apart for breeding purposes, thus annually weeding out all the pale-coloured worms.

M. Onesti has found that wood-soot, if sprinkled over silkworms attacked with *fébrine*, effects an almost certain cure, or, at all events, prolongs their lives until the cocoons are finished. The French Minister of Agriculture has addressed a circular to the *préfets* of the sericultural departments of France, and has requested that a commission be formed to report on the value of M. Onesti's discovery.

Professor N. Wagner has discovered a fact in natural history, which at first sight appears incredible; but it is supported by preparations, an inspection of which has convinced Professor de Filippi of the truth of the observations. Professor Wagner found in June 1861, under the bark of a dead elm, some whitish apodal worms, which proved to be the larvæ of insects. Each larva was filled with smaller larvæ, at first supposed to be parasitic; but the smaller larvæ were found upon closer examination to be identical, even to the smallest details, with the enveloping larvæ, by which identity Professor Wagner was led to assume that the included larvæ represented a second generation produced by the enveloping larva. This would be a case of alternation of generations, even more surprising than that of the aphides; and this interpretation has several circumstances in its favour, *viz.* the identical character of the inclosed and enclosing larvæ—their simultaneous development—the presence of enclosed larvæ not in some but in all the larvæ—and, lastly, that in the interior of the larvæ of the second generation, a *third* generation is produced precisely similar to the first two. Professor Wagner has observed three other species of the same genus, all presenting this singular mode of reproduction. The perfect insects are still unknown, but from the appearance of the larvæ, they seem to be of the order diptera.

We read in 'Cosmos' a letter from M. Duchesne Thoureau relating to a pattern taken from a large *tapis*, entirely due to the work of a group of spiders in a state of captivity. He expresses his belief that it is quite possible to produce by the aid of such auxiliaries, and without expense, soft and warm carpets, to arrive at which results it would only be necessary to dispose of a number of working spiders, and over a space proportionate to the magnitude of the work desired.

From the works of Oersted, Grube J. Müller, &c., it appears that the genus *Autolytus* presents the peculiarity so rare among Aurelids of a striking polymorphism, the males being so different from the females, that the two sexes have been described as belonging to distinct genera. There exists also in each species a third form, namely, the asexual form, which produces the sexual individuals, by gemmation at its posterior extremity, the alternation of generations in these worms being thus well established. M. A. Agassiz has found in the harbour of Boston, the *Autolytus* of which the males were described by Oersted in 1843, from Greenland, under the name of *Polybostrichus setosus*. He has, likewise, observed in the same locality, another species, to which he has given the name of *Autolytus cornutus*, a species which appears to be nearly related to the European species, *A. Heligolandiæ*. The differences between the individuals of the two sexes are of the same nature as in the European species. The females, at the moment of their detachment from the organic individuals, possess no ovigerous sac, but it is soon formed, and the ova deposited in its interior. The embryos are rapidly developed, and their escape from the sac appears to cause the death of the female, for M. Agassiz has never met with females after their embryos have escaped. The embryos at the moment of issuing from the sac have a triangular outline, their body diminishing rapidly towards the posterior externity.

The frequency with which the minute parasitic worm, *Trichina spiralis*, has been found of late in the muscles and intestines of the pig, and the fatal and serious results which have attended the consumption of flesh so contaminated, has spread a panic throughout Germany, and a committee has been appointed by the Berlin Medical Society, consisting of Virchow, Remak, Gurlt, and others, to examine into and report upon the subject. Thus far the disease has not been met with in any animal that is a vegetable feeder; but Dr. Langenbeck says, that *trichinæ* have been found in extraordinary numbers in earthworms last year—as many as 500 or 600 having been observed in a worm of middling size—and these worms form part of the food of those animals which swine devour when left at liberty. He advises that the swine should be always fed in styes, and debarred access to localities where worms are numerous.

It is seldom that a natural object proves so complete a puzzle to the initiated as one which has recently been brought to light. It is an elongated semicylindrical body, whitish, and rough like shagreen, length about two feet. It was purchased by the Rev. H. H. Higgins of a dealer in London, for the Liverpool Museum, where, struck by its remarkable and anomalous character, he showed it to Dr. Gray, who took it to London. It has been examined by Milne-Edwards, and

other *savants*, but no one appears able to identify it. The impression is, that it is echinodermatous in its nature, and it has been provisionally named by Dr. Gray *Myriosteon Higginsii*. This remarkable object has been transferred to the National collection in the British Museum.

The Zoological Society of London.

Little of general interest has transpired at the meetings of this Society during the past quarter, the most important communications being those of the Secretary, Dr. Sclater, either from persons residing abroad, or his own observations upon recent arrivals, and upon the animals in the Society's gardens. Perhaps, the most interesting communications were those relating to the collection of animals made by Captain Speke, during his expedition to Eastern Africa.

Dr. Sclater described the mammals and birds; Dr. Günther, the reptiles and fishes; Dr. Dohrn, the mollusca; and Mr. F. Smith, the insects collected by the great African traveller. Thirty-eight species of mammals were enumerated, amongst which the most remarkable was a new antelope of the genus Tragelaphus, which it is proposed to call *T. Spekii;* and sixty-one birds, including five new species.

This was at the meeting on the 8th of March. Mr. F. Buckland also read an interesting communication upon the habits of the spawning trout. He had learned easily to distinguish between the male and female at a glance as they swam; the male is always long in body, and generally has a hook-like projection from the lower jaw, the colour of the abdomen always chocolate, and a white line running along the pectoral fin, and usually on the ventral also. The female is shorter and rounder, and more wild and timid. He had succeeded in hybridizing the salmon and trout, and hoped in time to naturalize in the Thames a fish two parts trout and one part salmon, which should so combine the habits and excellencies of the two, that the non-migratory instinct should predominate over the migratory, and the fish thus be induced to remain up river.

On the 22nd March the Secretary drew attention to some recent additions to the ménagerie, the most remarkable of which were a young American monkey (Pithecia Satanas), and four examples of the Rufous-tailed pheasant (Euplocamus erythrophthaimus), the latter having been presented to the Society by their corresponding member, the Baboo Rajendra Mullick, of Calcutta.

These birds formed part of a collection brought over by Mr. J. Thompson, the Society's head-keeper at Calcutta, and presented by the native gentleman just named. Mr. Thompson had so ably managed the transport from Calcutta, as only to have lost a single bird on the passage.

Amongst other arrivals announced by Dr. Sclater (April 12th) was a living example of the tooth-billed pigeon (Didunculus strigirostris), presented to the Society by Dr. George Bennett, of Sydney, along with some other rare Australian birds. At the subsequent meeting, April 26th, Dr. Sclater announced that Mr. Latimer, the Austrian

Consul at Porto Rico, had offered, through Lieut.-Colonel Cavan, to obtain for the Society some living Manatees (Dugongs), and that arrangements were being made for the transport of the animals to this country.

Amongst the papers descriptive of new collections, read by the Secretary (the specimens being, in some cases, exhibited), was one of birds collected by Rev. H. B. Tristram, now in Palestine. Amongst these were two new species, which Mr. Tristram proposed to call *Passer Moabiticus*, and *Caprimulgus Tamarioca*. Also a paper referring to a collection made by Mr. G. H. White, in the vicinity of Mexico, amongst which were several additions to the avi-fauna of that country, and other papers describing single examples of special interest to zoologists.

At the meeting on the 22nd of March, Dr. Günther read the first part of an account of a large collection of fishes made by Capt. Dow, and Messrs. Salvin and Gorman, at Panama, among which were many new and interesting species. He pointed out the structure, and mode of operation of a poison apparatus in a new species of fish of the genus *Thalassophryne*, belonging to the family *Batrachidæ*, which it was proposed to call *T. reticulata*. The poison organs consist of four hollow spines, two of them being dorsal, and the others formed by the acute termination of the operculum posteriorly. The canal in the interior of the spines terminates in each case in a sac, in which the poisonous fluid is collected. In the specimens examined by Dr. Günther, which had been preserved in spirits for nine months, the slightest pressure of the sac, situated on the operculum, caused a whitish fluid contained in it to flow freely from the hollow extremity of the opercular spine.

In the account of this apparatus, which appeared in the last number of the 'Natural History Review,' it was stated that, "although many fishes have long had the reputation of being considered poisonous, no trace of any poisonous organ has been detected in them." This is an error. In the Proceedings of the Liverpool Literary and Philosophical Society, No. V. p. 156, is an excellent account of the anatomy of the stinging organs of the sting-fish, or Lesser Weever (Trachinus vipera), by Mr. I. Byerley, F.L.S., Seacombe, Birkenhead, accompanied by illustrative plates. In this paper the existence of poison glands in connection with the dorsal spines is demonstrated, and the character of these organs in our well-known British fish appears to be very similar to that described by Dr. Günther, in the *Thalassophryne* from Panama.

One or two communications of interest have been made by Dr. J. E. Gray, F.R.S. On the 24th May, that gentleman described the cetaceous animals which have been observed in the seas surrounding the British isles, of which he enumerated twenty-eight species as having occurred on the coast of this country. At the same meeting he read a note upon *Urocyclus*, a new genus of terrestrial gasteropodous mollusks, discovered by Dr. Kirk (of Dr. Livingstone's expedition), in the Zambesi river. On March 8th, Dr. Gray described a new species of tortoise, discovered by Mr. Osbert Salvin, in Guatemala,

to be named *Staurotypus Salvinii*. He also read a paper upon the Chelydidæ, as distinguished by their skulls; and gave a synopsis of the sand-moles of Africa, including a description of two new species discovered by Captain Speke.

Amongst the notes read at the various meetings were the following:—by Mr. Flower, of the Royal College of Surgeons, on a lesser Fin Whale (Balæna rostrata), stranded upon the coast of Norfolk; by Dr. E. Crisp, on the Anatomy of the Eland; by Dr. Geo. Bennett, on the habits of the tooth-billed Pigeon (Didunculus strigirostris); and by Mr. J. K. Lord, upon the use of a shell of the genus *Dentalium*, as a currency medium by the natives of Vancouver's Island, British Columbia.

XII. CHRONICLE OF RECENT SCIENTIFIC PROGRESS IN AMERICA.

By Henry Draper, M.D., Professor of Natural Science in the University of New York.

Since the breaking out of the civil war in the United States in 1861, a strong military tendency has been communicated to scientific pursuits. This is well seen in the records of the Patent Office at Washington, where, during the past three years, not less than 1,140 improvements in cannon, projectiles, cartridges, &c., have been patented. A considerable number of these refer to attempts at producing breech-loading weapons of large calibre. The application of this principle has thus far been unsuccessful, and probably will continue to be so, on account of the difficulty of securing strength without unwieldiness. In smaller cannon it has been partially successful, while in fire-arms it has done so well as to give rise to serious discussion concerning the propriety of abandoning muzzle-loaders altogether.

The most effective artillery that the war has produced has been the Parrot rifle, and the Rodman hollow-cast 15 and 20 inch guns. The former consists of a cast-iron barrel, strengthened at the breech by a reinforce of wrought iron. The durability of these weapons is so great, that a 30-pounder used against Charleston was fired 4,615 times before bursting. The range was five miles. The largest size as yet furnished for active service is a 300-pounder; many 200-pounders have been made.

For heavy battering purposes and the destruction of iron-plated vessels, the Government has encouraged the construction of smooth-bore cannon of great calibre; one of the forts in New York harbour having a battery of 15-inch guns, carrying 440-pound balls. The efficacy of these was tested in the battle between the 'Atlanta' and 'Weehawken,' in which the latter virtually decided the contest by the first discharge of her 15-inch gun prostrating 40 men.

XUM

A 20-inch gun too has been recently successfully cast at Pittsburg on Rodman's principle. In order to make this monster piece of ordnance, which will throw a solid shot of 1,000 pounds, 104 tons of metal were melted, though the gun will only weigh, when finished, 56 tons. The essential feature of this system of casting is to cool the iron mass from the interior by means of a stream of water, which is sent to the bottom of the bore in a properly protected pipe, while the exterior is kept hot by a fire round it. In this instance air was substituted for the water after a certain length of time, as the water was found to lower the temperature of the metal too quickly. The running of the iron occupied only 21½ minutes, and the gun was ready for the lathe in a fortnight. These hollow-cast guns are also very durable, the 15-inch at Fortress Monroe having been already fired 505 times.

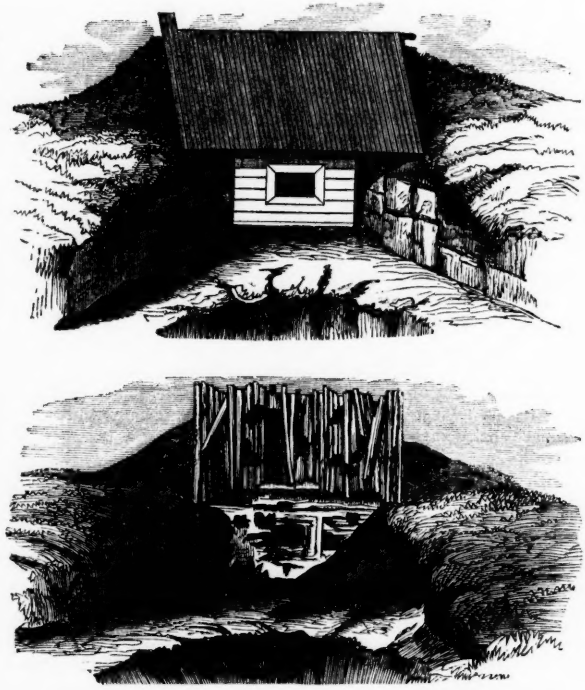
The use of gun-cotton, which is attracting so much notice on account of the Austrian experiments, has not met with favour. Up to the present, it has only been the solution in ether and alcohol that has been rendered available. By the aid of a coating of collodion, a cartridge of compressed gunpowder is made perfectly waterproof, and yet may be inflamed by a percussion cap without being torn open by the soldier. The advantage in rapidity of loading and freedom from dampness is very obvious.

Much attention too has been directed to defensive as well as offensive warfare. Iron-plated vessels in large numbers have been built, the Government having a fleet of 75 on hand, or to be soon completed. The favourite style of protection has been with many layers of plates bolted or riveted together, and, where possible, backed with two or three feet of oak. A few vessels with solid plates of 4½ inches thickness have been constructed; but since it has been found that the 21-inch gun with cast-iron round shot would penetrate such armour, they are no longer regarded as perfectly protected. The 'New Ironsides,' a ship of this kind, has, however, done well, not less than ten 10-inch shot having struck her near the water line, without doing any serious damage. She has been hit 213 times without losing a man.

When a person enters a Monitor turret, he cannot fail to feel a sensation of absolute protection, surrounded as he is on all sides by 11 inches of iron. The only loss of life in these structures has been from boltheads flying off; but now that the use of through bolts has been dispensed with, this cause of insecurity no longer exists. In the iron-clad cruiser 'Dictator,'—320 feet long, 50 feet beam, and 20 feet depth of hold—which is at present making ready for a trip to Europe, the turret has been increased to 15 inches, and the side plating to 11 inches, with three feet of oak. She is expected to be quite fast, having two 100-inch cylinders of 4 feet stroke. The armament is only two guns, but they are of built-up wrought iron, and of 13 inches calibre. The maker, Mr. Ericsson, is to receive 1,000*l.* for every pound of powder over 50 pounds that they will burn. The risk of encountering a sea voyage has already been undertaken by Mr. Webb, who has just sent the 'Rè d'Italia,' iron-clad 44, to Naples. She made

the passage in 18 days and 18 hours, though the sea was so rough that the accompanying Italian frigate was almost lost.

As regards the protection of forts by iron, a paper has been written by General Barnard, in which it is shown that the only parts necessary to be protected in sea-coast works are the embrasures. In landworks he suggests having turrets in the salients, and, perhaps, sheathing the scarp wall. In the constructions of this kind, hitherto tested under fire, the plating has been with a double layer of railroad iron. After the capture of Fort de Russy, some experiments were made on such casemates, when it was found that they were very soon wrecked by the fire of 9-inch guns. The appearance in the figure shows the effect on casemate No. 2, at Fort Hindman, of the fire of the iron-clad 'Lexington,' at 400 yards. It is copied from the official drawing.



The most interesting mineralogical novelty is the development of petroleum boring. The quantity of this fluid exported during the past year was about 28,000,000 gallons, and the amount derived from its sale 2,400,000*l*. The export in 1861 was 1,112,476 gallons; in

1862, 10,887,000 gallons. The total production in 1863 is estimated at 80,000,000 gallons.

The greater proportion is obtained from Oil Creek Valley in Pennsylvania. Many of the borings are 500 feet deep, though some much less deep have yielded largely. These latter, however, required pumps, while the former, called "flowing wells," eject their contents in some cases to a height of 100 feet above the ground. The petroleum is discharged by pipes into vats, where the salt water with which it is associated separates. In this state it is worth about fourpence a gallon, though there have been occasions, when the market was glutted, in which it has sold for not more than two shillings a barrel of 40 gallons. The owners of the wells are now able to control the discharge by stopcocks fixed on the pipes that line the borings, and when the price is low, limit the supply.

Crude petroleum has to be submitted to distillation in order to separate the benzine, which boils at 140° F. from the heavier oils, and these, in their turn, from the solid hydrocarbons. The proportion of these ingredients varies so greatly (some wells producing so large a percentage of the heavy oils), that the product is only suitable for greasing machinery. Unfortunately, it "gums," as mechanics say, and unless tallow or animal oils are added to it, it cannot replace sperm oil.

The exact source of petroleum is, up to the present, uncertain, whether it has all been produced by distillation from bituminous coal, anthracite being formed at the same time, or whether it has resulted directly from the bituminous fermentation of marine plants antedating the coal and containing a larger proportion of hydrogen.

The amount thrown out by some of the wells is enormous. One of them ejected 3,740 barrels a day, three 1,000 barrels, one 800 barrels. To "strike ile," has become throughout that region the synonym for rapidly growing wealthy. Transportation to market is effected by carrying it down the stream in vessels, many of which are merely tanks. Occasionally, when collisions occur, thousands of gallons are lost, floating away on the surface of the water. It is proposed to collect the fluid again by means of floating dams, shaped like a V, with the point up stream.

The effect that this illuminating agent has produced throughout the country is very striking. It has entirely displaced all other means of lighting, except gas, and is used even in cities by many who desire an absolutely steady light. The great desideratum is, a perfect chimneyless burner. The petroleum requires a large amount of air for complete combustion of its carbon, and by no other means than a tube 6 or 8 inches long has the supply been rendered sufficient. Although by the substitution of mica for glass the difficulty of breakage has to a certain extent been overcome, there is still great room for improvement.

Kerosene, as the oil suited for burning is called, has in one sense increased the length of life among the agricultural population. Those who, on account of the dearness and inefficiency of whale oil, were accustomed to go to bed soon after sunset, and spend almost half their

time in sleep, now occupy a portion of the night in reading or other amusements; and this is more particularly true of the winter season.

Benzine has come largely into use to supply the place of turpentine, especially for painting. It seems to be a good substitute for that now almost unpurchasable commodity, though painters have been forced to change their processes of mixing.

Professor Wolcott Gibbs has recently investigated the relations of hyposulphite of soda to certain metallic oxides. He finds that it can be used instead of sulphydric acid in precipitating nickel, cobalt. iron, alumina, zinc, and manganese from their solutions, if the mixture be raised to 120° C. In the old process as suggested by Himly, the temperature employed was not greater than the boiling point at the ordinary pressure of the air, and the reduction, though occupying several hours, was often incomplete. Gibbs uses a combustion tube hermetically sealed, heating it in an air bath for about an hour.

Mr. M. Carey Lea has examined the influence of ozone and some other chemical agents on germination and vegetation. He finds that ozone tends to check the growth of young plants; wheat in air growing 10 inches, while that exposed to ozone grew 4 inches. Ozonized air also diminishes the length of the roots, those exposed to it only becoming $\frac{3}{16}$th of an inch long, while the others increased to $2\frac{1}{2}$ inches. He concludes, that though ozone is a highly oxidizing agent, it may in some cases put a stop to putrefaction, by destroying the low order of vegetable organisms, which Pasteur has shown to be to a large extent the medium of effecting such changes. Mr. Lea has also noticed that oxalic and picric acids, even in very weak solutions, entirely prevent germination. The seeds were placed in all these experiments on gauze, resting on the surface of water.

Some facts regarding the great mass of copper found in the Minnesota mine, 120 feet below the surface, have been lately published. It was 45 feet in length, 22 feet at the greatest width, and 8 feet at the thickest part. It weighed 420 tons, and contained 90 per cent. of copper.

Mr. James D. Dana has continued the publication of his memoir on the classification of animals, based on the principle of cephalization. It is also being printed in England.

Professor J. D. Whitney is steadily progressing with the geological survey of California. The maps are mostly on a scale of $\frac{1}{2}$ inch to the mile. He has discovered that Mount Shasta, 14,440 feet high, probably overtops all other peaks in the United States; Popocatapetl, 17,783 feet high, the loftiest mountain in North America.

Professor Charles A. Joy has given the analysis of a meteorite found in Chili, weighing 1,784 grammes; it contained—

Nickel iron	(with Co, Mn, and Cu)	48·689
Sulphide of iron	Fe S	7·405
Chrome iron	$Cr_2 O_3$ Fe O	0·701
Schreibersite	(Fe 1·38 Ni 0·67 P 0·115)	1·563
Olivine	R O_3 Si O_3	11·677
Labradorite	($R_2 O_3$ Si O_3 + 4 R O Si O_3)	29·852
Tin stone	Sn O_2	0·189
		100·076

Mr. T. Sterry Hunt, of the Geological Survey of Canada, has, under the title 'Contributions to Lithology,' given an exposition of the theoretical considerations which he thinks should serve as a basis to lithological studies. He has also pointed out desirable reforms in the classification and nomenclature of crystalline rocks.

Dr. John Dean has published in the Smithsonian Contributions to Knowledge a beautifully illustrated memoir on 'The Gray Substance of the Medulla Oblongata and Trapezium.' The object has been to give the topography of those parts, with illustrations from a series of photographs made by himself. The photographs are of two kinds, on albumen paper and photo-lithographs. The former are only furnished for private distribution, but the latter are so well executed, that all the essential features are preserved. Photo-lithography has now advanced to a high degree of perfection; but in 1856, when Professor J. W. Draper was making the microscopic photographs, which his work on Human Physiology demanded, it was found necessary to copy them by hand on the wood.

REVIEWS.

METALLURGY.*

In all probability, the art of reducing Metals from their ores dates amongst the very earliest of the evidences, which we possess, of the exercise of human reason, in the infancy of mankind, upon the crude natural products of the Earth. The poets have imagined the discovery of the metals to have been accidental.

> "When shady woods, on lofty mountains grown,
> Felt scorching fires, whether from thunder thrown,
> Or else by man's design the flames arose,—
> Whatever 'twas that gave these flames their birth,
> Which burnt the towering trees and scorched the earth;
> Hot streams of silver, gold, and lead and brass;
> As Nature gave a hollow proper place,
> Descended down and formed a glittering mass." †

Accidents do not strictly belong to the advances of science. The same phenomenon may occur unnoticed for ages; but, eventually, a mind *prepared* to receive the truth, seizes the indication and gives it a practical value. Many strong objections could be urged to the poet's view; but since the story of Metallurgy is lost to history, the above tradition is as worthy of reception as any other.

The oldest records inform us that a considerable degree of perfection in the working of Metals had been acquired ere yet History had begun to keep her record. Job and Jeremiah use the refining of silver as symbolic of the condition of the people, by whom they were, each in his respective age, surrounded. Hesiod and Homer describe the precious metals, and especially notice the valuable applications of Bronze and Iron. Archæologists have, as it appears to us, somewhat hastily, made the divisions of a Stone age, a Bronze age, and an Iron age, to represent certain steps in the upward march of our race. That the use of Bronze should have preceded the use of Iron is not probable. That they were used at the same period, in the early days, is certain, since we have examples from Assyria of Bronze being cast upon cores of Iron.

Tubal Cain, "the instructor of every artificer in brass and iron," is curiously repeated by every nation as the one originator of these arts. The name varies with the people; but whether it be the Tubal of the Hebrews, or the Voelünd of the Scandinavians—the "Master Smith" is the one man who is worthy of "worship and honour."

* 'Metallurgy: The Art of Extracting Metals from their Ores, and adapting them to various Purposes of Manufacture.' By John Percy, M.D., F.R.S.
'Fuel, Fire-clays, Copper, Zinc, Brass. &c.,' vol. i.
'Iron and Steel,' vol. ii. Murray, London.

† 'Hesiod.' *See* 'Watson's Chemical Essays.'

However discovered, men must have used the simple metals before they employed the alloys. Nothing is more curious, in the history of human progress, than the fact, that the oldest tombs of Egypt, the buried palaces of Assyria, the "giants' graves" of Northern Europe, and the Celtic remains of our own Islands, yield Bronzes identical in their composition, and differing not from that which we now employ. Bronze is a mixture of Copper and Tin. Before these could have been combined, either in Egypt or Assyria, man must have obtained his Copper from the Peninsula of Sinai—and his Tin from the British Isles, or the Islands of the Indian Archipelago. Therefore, navigation must have advanced to that state which would have taught him to traverse wide and distant seas; and when the metals were obtained, experimental science must have determined the true proportions for making the best combination for implements or weapons.

The history of the Arts points to a much higher antiquity than that which we have hitherto been in the habit of assigning to the human family.

We have not to deal especially with the history of Metallurgy in considering the volumes which are before us, since they treat mainly of the practice of this Art. It was difficult, however, to resist the temptation of a few remarks on its antiquity, and the state of perfection at which it had arrived, at a very early period. To many, the mere smelting of the ore of a metal is a simple operation which an untrained mind could carry out. A glance at the two volumes on Metallurgy by Dr. Percy will show that every stage of reduction demands an amount of knowledge which can only be acquired by long-continued experiments, or close scientific study. By the latter the labours of the former may be much reduced, but never dispensed with.

England is the great metallurgical country of the world. Within her sea-girt Isles she possesses a greater variety, and a larger quantity, of the metalliferous minerals than are found in any other part of the Earth, within the same area. Gold and Silver—Copper—Tin—Lead—Iron—Zinc—Antimony—Cobalt—Nickel—Bismuth—and the ores of the rarer metals are found; and from one end of the land to the other, the blaze of the furnace proclaims the industry of her sons in reducing them to the metallic state. Tin smelting-houses in Cornwall; Copper works around Swansea; Zinc works in many places; Lead "smelt-mills" in the Northern Counties, North Wales, and other districts—and 562 Blast Furnaces in operation, proclaim the activity of our Metallurgies. Although we produce annually Metals and Coals to the value of 34,691,000*l.*, our literature has remained barren of Works treating of this subject. If we name some half-dozen on Metallurgy our list will be exhausted—and in no one of these is the subject treated with the desired comprehensiveness.*

* The following are the works alluded to:—

1. 'A Treatise on the Progressive Improvement and Present State of the Manufactures in Metal.' 2nd edition. Edited by Robert Hunt. 1853. Longmans, London.

2. 'A Manual of Metallurgy.' By John Arthur Phillips. Griffin, London.

3. 'The Useful Metals and their Alloys.' By Scoffern, Truran, Clay, Oxland, Fairbairn, and Aitkins. Houlston & Wright.

The 'Metallurgy' of Dr. Percy is published to meet a want which has long been felt, and which we rejoice to see, at last, adequately supplied. The two volumes which are completed (we think it wise to include both in our notice, although Vol. I. was published in 1861) embrace the most important Metallurgies, and they really leave but little to be desired. The author is peculiarly fitted by his education, and his opportunities, for the production of a work which must be equally acceptable to the manufacturer and the man of science.

To place an Ore of Lead—or Copper—or Iron in a fire, and by the intensity of heat to run out a fluid metal, is certainly a simple matter. But when we remember that nearly all ores are of a very compound nature; that the chemical affinities in action are of the most powerful kind; and that the metallurgist has so to direct his skilled labour, that a metal, as nearly pure as possible, may be the result, we shall be convinced that a considerable amount of scientific knowledge is required.

"As the word science in relation to a manufacturing art is often vaguely used, it may be well to give the following illustration of its meaning:—When an ore of copper, consisting essentially of copper, iron, sulphur, and silica, is subjected to a series of processes, such as heating with access of air under special conditions, melting, &c., copper is separated in the metallic state. The sum of these processes is termed the smelting of copper. In this operation of smelting, certain chemical changes take place: the sulphur combines with the oxygen of the air, and is evolved chiefly as sulphurous acid; the iron is similarly converted into oxide, which combines with the silica present to form a fusible compound or slag. There are thus several facts which are proved on chemical evidence. These facts, when systematically arranged, may be said to constitute the scientific knowledge of copper smelting: and that knowledge implies necessarily a knowledge of the chemical relations of copper, iron, sulphur, oxygen, and silica to each other. . . . The man who conducts the process of copper-smelting in ignorance of these facts, has simply an empirical, in contradistinction to a scientific, knowledge of the art."*

Dr. Percy's aim has been to give, in this work, clear technical descriptions of each process, and to explain by the light of science, the philosophy, if the word may be allowed, of every step. To do this, close and laborious study, at the furnace mouth, has been necessary, and this has been followed by a searching analysis of the products, in the quiet of a well-regulated laboratory.

This work is intended to convey the largest possible amount of information relating to the production of the Metals Nature gives us but two or three in a pure or *native* state, and, as it is designed with all things, the power of mind is necessary to mould them to a condition in which they become useful. Therefore, this work, very

4. 'Papers on Iron and Steel, Practical and Experimental.' By David Mushet. John Weale, London.

5. 'The Iron Manufacture of Great Britain, Theoretically and Practically Considered.' By William Truran, C.E. E. & F. N. Spon, London.

6. 'An Elementary Treatise on Iron Manufacture.' By Samuel Baldwyn Rogers. Simpkin, Marshall, & Co., London.

* 'Metallurgy:' Introduction.

logically commences with the *Physical Properties of the Metals*—and some *General Considerations on Metallurgical Processes*, proceeding to a full examination of *Fuel*, and then entering on the special Metallurgies of the useful Metals.

The development of Heat is necessarily a most important study to the Metallurgist. Heat of high degrees of intensity is required—and this must be produced with the utmost economy. The characteristics of various kinds of Fuel—such as Wood, Charcoal, Peat, Lignite or Brown Coal, Coal, Coke, and Anthracite, are therefore matters of interest. Hence Dr. Percy has devoted a large portion of his first volume to their consideration. We should be wanting in justice if we failed to state our high appreciation of the original matter,—experiments made with the most scrupulous care, and deductions drawn with philosophical acumen,—which marks this division of our author's labours.

That, notwithstanding all that has been written on the subject of Coal, and all the examinations to which this Fuel has been subjected by Chemist, Geologist, and Naturalist, we should be unable to answer the question, "What is Coal?" is a sad reflection on European philosophy. In 1853 a remarkable trial took place at Edinburgh before the Lord Justice General and a special jury to try this question. The result is well put by Dr. Percy:—

"At the trial there was a great array of scientific men, including chemists, botanists, geologists, and microscopists; and of practical gas engineers, coal-viewers, and others, there were not a few. On the one side it was maintained that the mineral was *coal*, and on the other that it was a *bituminous schist*. The evidence, as might be supposed, was most conflicting. The judge accordingly ignored the scientific evidence altogether, and summed up as follows:—'The question for you to consider is not one of motives, but what is this mineral? Was it coal in the language of those persons who deal and treat with that matter, and in the ordinary language of Scotland? *because to find a scientific definition of coal after what has been brought to light within the last five days, is out of the question.* But was it coal in the common use of that word, as it must be understood to be used in language that does not profess to be the purest science, but in the ordinary acceptation of business transactions reduced to writing? Was it coal in that sense? That is the question for you to solve.' The jury found it was coal. Since this trial the same mineral has been pronounced *not to be coal* by the authorities of Prussia, who accordingly have directed it not to be entered by the custom-house officers as coal." *

While these paragraphs are being written the question is again before the Courts. Evidence equally as conflicting as that given on the former trial has been tendered by the men of science on this. Judgment has again been given in the plaintiff's favour, and for the third time the Boghead mineral is decided to be *a coal*. This trial furnishes another example of the degradation of science, whenever its students are induced to use their ingenuity as Special Pleaders in a Court of Law. Dr. Percy says, "In the present state of science I do not believe it possible to propose an exact definition of the term coal."

* Vol. i. p. 78.

This confession shows the limited capacity of our language—the poverty of our knowledge—the uncertainty of our scientific definitions—and of the nomenclature of science when it advances—or rather attempts to advance—from mere details to enlarged generalities.

Naturally following the subject of Fuel, the Fire-clays and Crucibles come under notice, together with Sands, Sandstones, and all the natural refractory Minerals employed in the construction of Furnaces, and as the means of exposing the Ores to the action of intense heat. This section cannot but be of great value to the practical man. Not only have we the results of the labours of our best Chemists and Metallurgists given in concise and clear terms, but we have a considerable amount of original research communicating much that is important.

The Metallurgy of Copper has the first attention, and that of Zinc follows. There are few metallurgical processes which require so large an amount of chemical knowledge as Copper Smelting. Dr. Percy has carefully described every stage in the process, and, at the same time, explained the chemical changes which mark each stage. Nearly every condition of the furnace products in their passage from the ore to fine copper, has been submitted to the most searching examination in the author's laboratory. There is one feature in connection with this research, and indeed with all the original investigations included in these volumes, which must be recorded with unqualified praise. In no case has Dr. Percy avoided giving his own assistants the full merits due to their labours. In some instances indeed we feel that he may have overstated the claims of those who have worked merely under his guidance.

The history of Copper Smelting in Great Britain has evidently been a favourite subject of inquiry. It is therefore very complete. Not only have we full details of all the processes employed in this country —with drawings of the furnaces, &c., to scale, but we have accounts of Copper Smelting in Sikkim, Himalya, and other parts of India, in Japan, Sweden, Prussian Saxony, and Russia. It is quite impossible to do more than thus hastily notice these valuable contributions to applied science, which must be studied in the work itself by all who are desirous of obtaining accurate knowledge on the subject.

The History of Zinc Smelting is touched on, but it is not so satisfactorily given as that of Copper. Indeed the, in every way, interesting story of this Metallurgy in our own island is dismissed in a few lines. This is to be regretted, since the mining and smelting of Calamine—especially that which was raised in the Mendip Hills—was, in the time of Elizabeth, so important as to give rise to Acts of Parliament directed to prevent the Exportation of Zinc, mainly to compel "*Copper to be brought in* for the manufacture of Gun-metal, Bell-metal, Schrof-metal, Latten," &c., &c. Dr. Percy quotes much of the matter collected by Dr. Watson and Beckman, who dealt mainly with the ancient use of Zinc, and but little of interest besides.

The second volume of 934 pages is devoted to Iron and Steel. This is, without doubt, the most important division of Dr. Percy's labours. He has departed from the plan pursued by him in treating of Copper

and Zinc. We have no special history introductory to the Manufactures of Iron and Steel, but a short sketch at the conclusion of the work. Much, it is true, will be found in the descriptions of the various processes, which is, in fact, their history. Still, we should have been pleased, as we believe many others would also have been, had the author devoted as much research to the History of the Metallurgy of Iron and Steel as he has done to that of Copper.

The Physical and Chemical properties of Iron are most ably dealt with, and every problem of interest in connection with the production of this valuable metal is carefully examined. The different states of *grey iron*, *white iron*, and *mottled iron* have been subjects of close investigation. Dr. Percy gives us his own researches into the modes of existence of Carbon in Iron on which these states depend, and also some account of every inquiry of any value which has been made by British or by Continental Chemists and Metallurgists.

Spiegeleisen, or specular cast-iron, which is now a product of the highest importance to the Iron and Steel manufacturer, has, of course, claimed a considerable share of Dr. Percy's attention. He clearly refers the peculiarity of this metal to the Manganese, which he finds in combination. Yet, he states sufficiently all the evidence which has been adduced to prove Spiegeleisen to be a definite compound of Carbon and Iron, the Manganese playing an unimportant part.

All the great questions of the combination of Silicon, Phosphorus, Sulphur, Titanium, and Tungsten with Iron or Steel are carefully examined, and this section of the work deserves the most careful attention of every Iron master. The numerous alloys of Iron are described, and most of the patent inventions (?) connected with this much disputed question, of the merit or demerit of alloying Iron or Steel with other metals, have a large share of attention.

The analyses of British Iron Ores is exceedingly complete. In 1851 Mr. S. H. Blackwell collected with much care, industry, and cost, examples of the ores then known. These were displayed by that gentleman in the Great Exhibition, and a very careful description of them, by him, will be found in the large catalogue of that Exhibition. This collection was given by Mr. Blackwell to the Museum of Practical Geology, and with it the sum of 500*l* "towards defraying the cost of analyzing all the more important of those ores." Analyses have been made in Dr. Percy's Laboratory of a very large number of these ores, and published, with descriptions of their modes of occurrence, at the expense of the Government.* The collected analyses, therefore, given in this work, are of the most trustworthy and complete character. The processes of smelting Iron in all parts of the world are described. We believe we may safely say that the author gives descriptions of every variety of Iron Furnace in use, and in nearly every case, the accompanying drawings are to scale. The sections of the English Blast Furnace which are given, are remarkable examples of the amount of care which has attended every stage of the

* 'Memoirs of the Geological Survey of Great Britain: The Iron Ores of Great Britain, parts 1. 2, 3, 4.' Longman & Co. London.

inquiry into this important division of Iron manufacture, and of the zeal with which author and engraver have laboured to produce the most satisfactory results. With the enormous development of our Iron industries, there has been, naturally, greatly increased attention to all the details of manufacture. Every stage of the process, from the casting of "mine" (iron ore) into the furnace, to the flowing out of pig-iron, has been rigorously investigated by the author; and, again, every step in the progress of manufacture, into "merchant bars," or the conversion of iron into steel, has been subjected to the most minute examination. The attention which has been given by Dr. Percy to all these points has ensured a great degree of exactness in his descriptions, and there is little left to be desired in any one of them.

The invention of "Puddling" by Henry Cort is now very satisfactorily established; and the story of his ruin, through the fraudulent conduct of his partner, Mr. Samuel Jellicoe, and the stupidity and blundering of the government officials with whom he had to deal, is stated by Dr. Percy with great lucidity, and with the most honourable and kindly feeling. We should perhaps explain, for the benefit of some of our readers, that "puddling" is a name given to a process by which *pig-iron*, molten on the bed of a reverberatory furnace heated by flame, is converted into *malleable iron* through the decarbonizing action of the oxygen of the air circulating through such a furnace. Pig-iron is, essentially, a compound of Carbon and Iron: other matters are combined with, and influence its quality, such as Sulphur, Silicon, Manganese, and Phosphorus. These are removed either by combination with oxygen when they escape in the gaseous form, or by mixing with the slag, when they are mechanically removed. The mean of many analyses of Pig-iron gives about 3 per cent. of Carbon, 2½ per cent. of Silicon, and 94 of Iron; that of Malleable Iron being about ¼ of a percentage of Carbon, and ⅛ of Silicon. This is to be considered as a general statement of the character of these two varieties of iron, the difference it will be seen depending upon the absence of Carbon or Silicon. Many processes have been devised to supersede the laborious operations of puddling, but none of them have been as yet entirely successful.

Steel is a third condition of Iron, in which some Carbon exists in a peculiar state of chemical combination with the Iron. Dr. Percy says:—

"The production of Cast-iron into Steel by partial decarburization may be effected in several ways: and of these are three of chief importance, namely, fining in a hearth with charcoal as the fuel, puddling in the reverberatory furnace, and the Bessemer process. The first is the ancient method, which is still extensively practised on the Continent, especially in Styria; the second is only of recent date, but has, nevertheless, made rapid progress; and the third is the most novel, and certainly destined to play an important part in the world. If Steel be regarded simply as Iron carburized in degrees intermediate between Malleable and Cast-iron, then it is obvious that the latter, during its conversion into the former in the process of fining and puddling, must pass through the state of Steel. Accordingly, it is found that by suitably regulating and arresting the

decarburizing action in these processes, Steel may be obtained instead of Malleable Iron."

The "Finery" process as practised over Europe is very satisfactorily described, and, as far as we are acquainted with it, the same may be said of the descriptions given of the production of Steel by puddling. The "Section on Decarburization by blowing atmospheric air through molten pig-iron," admitted by Dr. Percy to be a process "*destined to play an important part in the world*," does not strike us as being so complete as is desired. This is the Bessemer process, which consists essentially in placing molten pig-iron in a vessel called a "converter"—an ellipsoidal vessel, made of wrought-iron,—and then forcing, by blowing engines, a blast of air through it. Dr. Percy says of this process:—

"I never witnessed any metallurgical process more startling or impressive. After the blast was turned on, all proceeded quietly for a time, when a volcano-like eruption of flames and sparks suddenly occurred, and bright red-hot scoriæ or cinders were forcibly ejected, which would have inflicted serious injury on any unhappy bystanders whom they might perchance have struck. After a few minutes all was again tranquil, and the molten malleable iron was tapped off."

By the action of the atmospheric air on the molten pig-iron, a temperature is obtained, higher than any ever before attained in metallurgical operations. This process is now in active operation in some of the largest works in this country, and others are engaged in adapting their works to receive the required machinery. In Sweden, Prussia, and France, the Bessemer process is superseding every other, and it promises indeed, as Dr. Percy says, "to play an important part in the world."

This invention was clearly arrived at by persevering industry, and an irrepressible hope which led the inventor to pass by failures as things of course, and steadily to work to the end which he has achieved, and for which he is now receiving a substantial reward.

We hope, in the second edition of this work, that Dr. Percy will give us the benefit of such a close examination of every stage of the Bessemer process as its high, admitted, importance demands, and which he has given to some of the other processes described by him.

We cannot refrain from expressing our regret that one feature, so strongly marked as to become a peculiarity, runs through this work. We allude to the desire, almost always shown, to trace back each man's thought to some often undeveloped thought of earlier and yet earlier date. The analytical character of Dr. Percy's mind has, to a great extent, led to this. The kindly spirit with which he reviews the history of the discoveries made by Henry Cort is a most pleasing exception to his rule. What the poet Coleridge said of those critics who were always endeavouring to find yet earlier footsteps in the snows of Helicon, in which the last adventurers on the hill of Fame had trodden, applies with equal force to the historian of science or of manufacture. We do not for one moment intend to dispute the correctness of any one of the statements made regarding early or foreign processes, nor do we intend to say that they are not in many respects

like those more modern processes with which they are compared. But in every instance where success has attended the recent process, it will be found to be due to some original thought, which renders the manipulatory details on which that success depends, an original discovery. Do not let us encourage the habit of endeavouring to diminish the small rewards, which, in the aggregate, are gained by inventors. In some few cases a substantial recompense for benefits gained is bestowed by the public on the originator of a novelty, but in by far the larger number, the sole reward is the consciousness that success has been deserved, although it has not been achieved.

There cannot be any difference of opinion, amongst those who are acquainted with Metallurgy, on the value of this work, as elucidating nearly every point of importance in the processes by which the ores are converted into metals. The man of practice may possibly think it would have given a more complete character to the work if the author had minutely dealt with the numerous phenomena which present themselves to the smelter. The man of science may feel that he desires on many points, an examination yet more searching than that which Dr. Percy has given. To the first we may reply that the minuteness desired by him would have detracted from the use of this work. It deals sufficiently with all the principal changes, chemical or physical, which are essential to the production of marketable metal. The minute details if described in a book, cannot be learnt from it, and therefore only tend to obscure the more important matters.

To the latter, we say, for special examinations you must go to special treatises, and remember that Dr. Percy has in nearly every instance indicated the sources from which he has drawn his facts, and from which the additional evidences can be obtained.

"METALLURGY" is a most valuable contribution to the Literature of Science and the Arts. It removes from us the censure that we did not possess a treatise on the metals, of any standard character, and it gives us a work to which we can with satisfaction refer, as setting forth in clear and intelligible language all that it is necessary to know of the processes employed in our large works, to give those results which have placed us as the first Metal-makers in the world.

We cannot conclude our notice without speaking of the numerous woodcuts which add greatly to the value of the book. In execution they are superior to any that can be found in our works on Science. The precision with which they have been copied, and the clearness with which the minute parts have been engraved, constitute them examples to all wood engravers who may have to deal with Mechanics or Engineering. The scale which accompanies each engraving adds greatly to its value, since this renders it easy to construct a machine or build a furnace without any other drawings.

The author, and all who have aided in the production of this work, merit the utmost reward which an appreciating public can bestow on a careful record of the most important of British industries.

COMPARATIVE ANATOMY AND CLASSIFICATION.*

One of the most striking qualities of the human mind is the perception of the order which pervades the universe; and one of its most remarkable tendencies is to arrange and classify all visible objects and perceptible forces. It matters not whether the objects are vast and distant, as the heavenly bodies; near and appreciable to the touch, as the constituent parts of the earth or the living objects on its surface; whether visible to the eye, as organic and inorganic beings of definite form and colour, or cognizable only through chemical or physical agencies, as gases, &c.; it is immaterial whether the forces be physical, as magnetism, electricity, light and heat, or vital, such as those which are especially manifested in plants and animals, or, lastly, even the phenomena of the human mind itself: the habit of man is always to deal with these various objects and powers in an orderly, systematic manner. And if this systematic or classificatory treatment were simply applied to such objects as minister to his own wants and desires, to plants, animals, useful or ornamental minerals and so forth, one might be disposed to regard this quality of the mind as an instinct analogous in some degree to the power of selection for utilitarian purposes possessed by some of the lower animals. But we find the very reverse to be the case; namely, that individuals and races of men who appear to have no higher aim than to satisfy their bodily wants, care little about the order or arrangement of the things which surround them, whilst men of the highest intellects (those, indeed, who often think the least about the practical uses of the objects that engage their attention) have from time immemorial been employed in detecting relations in natural objects, and in drawing up systems of classifications to embrace all forms having characteristic features in common, whether in the organic or inorganic realm of nature.

That such systems of grouping or classification are chiefly, if not entirely, the creations of the human intellect, few will be disposed to doubt who have perused the past history of any branch of science, and it is obvious that like many other aids to education, they have been invented for the purpose of facilitating the acquisition of knowledge. Were man acquainted, for instance, with the form, structure, and vital attributes of all living and fossil animals, he would not conceive of the animal kingdom as parcelled out into sub-kingdoms, classes, orders, families, &c., but it would present itself to his mind as one perfect connected whole; and if for the convenience of reference, it pleased him to retain these old boundaries, it would only be as he now rules the meridians upon his maps; for they would no more have a real existence than have the lines of latitude and longtiude upon the surface of the globe.

Another curious phenomenon in connection with this faculty of

* 'Lectures on the Elements of Comparative Anatomy,' by Thomas Henry Huxley, F.R.S., Professor of Natural History, Royal School of Mines, &c; 'On the Classification of Animals, and on the Vertebrate Skull.' John Churchill & Sons, 1864.

classification, is that it has a value apart from the knowledge of the objects of which it treats. As this is a somewhat vague expression, we would explain it by saying, that the knowledge how to classify is *one* science, whilst an intimate acquaintance with the subjects classified is *another;* it is not at all unusual to find a clever systematiser who has little intimate practical knowledge of the large majority of objects which he arranges according to their leading properties, whilst there are innumerable so-called practical men of science to whom systems of classification are almost unknown. When, however, we meet with an individual proficient in both departments of knowledge, it may naturally be expected that any new arrangements proposed by such an one, will be valuable to students and observers. In no branch of science have there been greater changes in regard to classification than in natural history; and when we restrict that term to its popular signification, zoology, we cannot fail to be struck with the great number of systems which have from time to time been recommended by men of undoubted eminence, subjected to alterations, corrections, and emendations, and which have superseded one another with astonishing rapidity. To the young beginner this circumstance is often a matter of great perplexity, and he frequently finds that when at the recommendation of a friend or teacher, having a particular bias, he has mastered the arrangement of some well-known systematic zoologist, he has a great deal to unlearn, before he can renew his studies on a par with those who have availed themselves of more recent, or perhaps more accurate systems of classification.

Some years ago, a favourite book with beginners was Rymer Jones's 'Natural History of Animals,'* a very attractive little work, well written, and beautifully illustrated, and one that has no doubt raised up many an active and useful devotee of science. The author of this book, believing all methods of classification propounded up to his time to have been very imperfect, set to work to build up a new one based upon the most recent experiences of his day. Aristotle, he told his readers, had simply classed all animals under two great heads, the one possessing colourless, and the other red blood, divisions which correspond with the *invertebrata* and *vertebrata*. Passing from the old Greek philosopher to the fathers of modern zoological science, he touched upon the systems of Linnæus and Cuvier, both of whom, recognizing in the structural peculiarities of animals suitable guides for classification (the external horny cases in insects, or the internal bony framework of the *vertebrata*, for example), based their arrangements upon these characteristics. But because the author could not find in them squares ready fitted to receive some of the more recently discovered forms of life, he was dissatisfied with both these systems, and regretting that the celebrated John Hunter had not lived long enough to carry out *his* physiological views in regard to classification (inasmuch as that great anatomist had obtained "an indistinct glimpse of the clue that would have served to guide him"), he announced that the researches of modern physiologists had "fortunately left us in no doubt upon the

* Van Voorst, 1845.

important question," for that the essence of all physiology points to the nervous system as the basis of all correct arrangements, and upon the presence, absence, or supposed characters of that system, he (the author) therefore based his classification. But supported as he was in this view by many men of the highest eminence, he soon found himself in the same dilemma in which he had placed Cuvier, the greatest systematic zoologist of the age; and in a work published some years afterwards,* he himself acknowledged the imperfection of his "neural" system of classification, and stated that "in the lower forms of the animal kingdom especially, we are far from being able to avail ourselves of such a guide." He did not venture, however, to substitute a better system, but employed the old one as a *pis aller*.

In referring to this fact, we by no means seek to disparage the author's labours in the cause of science; on the contrary, we consider that the acknowledgment of the imperfection of his system redounds to his praise, and exhibits a moral courage not often possessed by scientific men.

Turning now to the Continent, we find two recent works on systematic zoology, both still regarded with great favour in scientific circles, and the authors of which have built their systems upon almost entirely dissimilar foundations. In his Guide to the Study of the Invertebrata,† Siebold has founded his classification upon the form and structure of animals, ranging them according to the simplicity or complexity of their organization, and availing himself of all known data of structure and development; whilst Vogt (whose work, with all its imperfections, is perhaps the best zoological handbook extant)‡ has built up his system solely upon the phenomena of development.

Nor is it surprising that Vogt should have singled out these phenomena; and although we shall presently perceive that his system was as much open to objection as that of other naturalists who direct their chief attention to one phase only in animal existence, we cannot be surprised at his having selected this one, for at the time he undertook his task, every day was revealing new features in the development of animals which appeared to set at defiance all previous modes of classification. To speak popularly, Echinoderms were found, first, to lead the life of "Acalephs;" Medusæ, that of the hydra; winged insects gave birth to others without organs of flight, and these again produced offspring resembling their grandparents; creatures that swam freely about in the water appeared to become degraded, and to belong to quite a different class, as entozoa, when their old habitat was changed for the internal organ of some warm-blooded creatures: and thus it became as difficult to define the true position of a vast number of animals which, in various stages of their existence, changed their form and character, as it would be for an uneducated man to

* 'The General Structure of the Animal Kingdom.' Van Voorst.

† 'Lehrbuch der Vergleichenden Anatomie der wirbellosen Thiere,' by C. Th. V. Siebold, being the first volume of the 'Lehrbuch der Vergleichenden Anatomie,' by Siebold & Stannius. Berlin: Veit & Co., 1848.

‡ Zoologische Briefe: Naturgeschichte der lebenden und untergangenen Thiere." 2 vols. Frankfort am Main Literarische Anstalt. J. Ruetten, 1851.

decide whether a butterfly ought to be ranked as a worm or as an insect; and it was found necessary to raise this and degrade that form of life, according to the stage in which it had been observed when its place in the animal kingdom was first assigned to it. But Vogt was not content to rectify the boundaries of former systems, and fill up gaps that had been left open through the imperfect knowledge of those who preceded him. The phenomena of development had taken such complete possession of his mind, that he allowed them to serve as his chief guide in classification; and thus we have the whole animal kingdom divided, according to his method, into three great groups, each possessing, as he believed, some marked embryonic peculiarity, or, more correctly speaking, each having a distinct method of reproduction. The lowest of these groups, comprising the forms now known as *Protozoa*, had (according to Vogt) no true ova; the second, embracing the *Radiata*, *Vermes*, and all the *Mollusca*, except the *Cephalopoda* (cuttle-fishes, &c.), was the result of the transformation (or absorption) of the whole yolk into the embryo; and the highest group in which he found the embryo developed distinct from the yolk (Gegensatz zwischen Embryo und Dotter) comprised the *Cephalopoda*, *Articulata*, and *Vertebrata*. In like manner, he was guided in the subdivision of these groups, especially of the last-named, by certain features in the development of the embryo *in ovo*, or of the fœtus.

This system of classification was always considered faulty by the leading zoologists of Germany; and we need only state that the Infusoria, which he classed in his group possessing no ova (kein Ei), have, through the recent researches of Dr. Balbiani, of Paris, been shown to be sexual and to produce ova; and that he would be compelled to seek some other feature in their structure or development in order to define their true position, to show that his system is quite as imperfect as those based upon any other single phase in animal life.

But our limited space prevents us from referring to other systems of classification, and with a passing tribute to the great zoologist Milne-Edwards, the worthy disciple of the illustrious Cuvier, whose labours have been transferred, with or without acknowledgment, to innumerable so-called Hand-books and Text-books, which have been published in almost every European language, we must now direct the attention of our readers to the work before us.

The first portion of the treatise, which is a reprint of a series of Lectures delivered by the Author at the Royal College of Surgeons, is devoted solely to the subject of Classification, and to the relations of one group of animals with another. As a series of essays on this branch of zoological science, it is not only very valuable to students who already possess some knowledge of the subject, but will be found deeply interesting to more advanced readers, who have not had the opportunities afforded to the author of watching the progress of systematic zoology during the last few years, or to those whose studies have been directed rather to practical and experimental zoology than to the literature of the science.

As regards the author's system of classification, he tells us that it is based "upon purely structural considerations," and that animals

have been regarded "not as related to other forms of life and to climatal conditions—not as successive tenants of the earth, but as fabrics, each of which is built upon a certain plan."

Availing himself of the Cuvierian classification, instead of aspiring to be the founder of a new method, he has built up the following improved zoological system :—

TABLE OF THE CLASSES OF THE ANIMAL KINGDOM.

The Limits of the Four Cuvierian Sub-Kingdoms are indicated by the Brackets and Dotted Line.

RADIATA.

Gregarinida. *Infusoria.* *Rhizopoda* (?). *Spongida.* *Hydrozoa.* *Actinozoa.* *Polyzoa.*		*Scolecida* (?). *Echinodermata.* *Annelida.* *Crustacea.* *Arachnida.* *Myriapoda.* *Insecta.*
		ARTICULATA.
Brachiopoda. *Ascidioida.* *Lamellibranchiata.* *Branchiogasteropoda.* *Pulmogasteropoda.* *Pteropoda.* *Cephalopoda.*	MOLLUSCA.	*Pisces.* *Amphibia.* *Reptilia.* *Aves.* *Mammalia.*
		VERTEBRATA.

As each of the foregoing groups, the author says, "embraces one of the principal types or plans of modification of the animal form," a precise knowledge of that which constitutes the typical structure of each of these groups" will serve to convey an exhaustive knowledge of the animal kingdom. He proposes, therefore, to "define the various groups," or where definition is not yet possible, "to describe a typical example." And it is due to Professor Huxley to say, that in thus seeking to present to his readers a correct outline of the animal kingdom, he has fulfilled all the conditions essential for the execution of his task; and where he falls short in its performance (as he acknowledges from time to time, in the course of his survey), it is not from any inability to classify and arrange, but owing to the want of materials with which to operate.

His illustrations (we mean his drawings), which necessarily form a most important feature in the work, have the merit of being to a great extent original, and those which are not so, are in most cases taken from the newest works bearing upon the special subject to which they refer, the observer's name being in every instance appended to them,—a rule which we recommend for more general adoption. The careful dissections of the author, more especially of the typical

examples *Phallusia*,* *Anodon*, *Helix*, and *Sepia*, are remarkably well adapted for displaying the organization of the groups to which they belong, and, in addition to a great number of typical illustrations taken from life, the student will find two little diagrams exhibiting, in a simple but striking manner, the distinctions between the general structure of the vertebrate and invertebrate types of the animal kingdom. In adopting, as he has done, the system of Cuvier, the author has displayed sound judgment, and, generally speaking, his additions and modifications, necessitated by the advances in zoological science, appear to be the best he could have made. We recommend this portion of his work to "science teachers," and to students who wish to base their knowledge upon a good foundation. For these purposes the language might have been simplified with advantage, but in no case is there a want of clearness, nor do we find in it any affectation of learning, although, as we have already said, the most important facts which have recently been contributed by the leading observers of the day, both at home and abroad, are included in his comprehensive review of the animal kingdom. To this retrospect the first six chapters of the work are exclusively devoted.

In our notice of those Lectures in Professor Huxley's work, in which the structure and development of the vertebrate skull and "the theory of the vertebrate cranium" are treated of, it is not our intention to attempt an analysis of the multitudinous details (many of which are of a most elaborate nature) therein discussed, but to confine ourselves to the consideration of some of the leading propositions laid down and conclusions arrived at.

Since the year 1807, when Oken, in his "Programm," first announced the remarkable hypothesis that the skull is but a peculiar modification of the vertebral column, the "vertebrate theory of the cranium" has more or less occupied the attention of many distinguished anatomists, and Spix, Bojanus, G. St. Hilaire, Carus, and Professor Owen, have published elaborate Memoirs, in which they have adopted the general conception of Oken, with more or less modification in the details of his plan.

The great reputation of the celebrated English anatomist, and the weight attached to his opinions, have induced many anatomists in this country to accept his views, without, perhaps, inquiring minutely into the data on which his conclusions are based. And in some of our anatomical text-books the nomenclature, and system of arrangement of the cranial bones into vertebræ, advocated by Owen, have been introduced, not without creating confusion, into the descriptions of the human cranium. There were, however, always a few anatomists who declined to give in their adhesion to the system of Professor Owen. Most prominent amongst these was Professor Goodsir, who, applying to the investigation of the subject the embryological researches of Von Baer, Rathke, Reichert, and Remak, pointed out, not only in his Lectures delivered in the University of Edinburgh,

* The description of this form, and perhaps of one or two more, is rendered somewhat obscure through an apparently incorrect lettering of the woodcut.

but more systematically in some highly philosophical Memoirs read before the British Association in Cheltenham, August, 1856,* the impossibility of reconciling many of the morphological conceptions of Owen with what is known of the mode of development of the cranium, and of its relations to the vascular and nervous systems. The necessity of combining embryological investigation with comparative anatomy in all our morphological inquiries was at once put on a firm and scientific basis by these Memoirs of Mr. Goodsir's.

In pursuing his investigations into the morphology of the skull, Mr. Huxley has employed both these methods of research, and has arrived at the conclusion "that the skull is no more a modified vertebral column, than the vertebral column is a modified skull: but the two are essentially separate and distinct modifications of one and the same structure, the primitive groove."

To make this proposition clear to our readers, it is necessary we should explain that one of the first indications of the development of the body of the vertebrate embryo is the appearance of an elongated linear groove in the blastodermic membrane, the anterior end of which, somewhat dilated, corresponds in position to the future head. At the bottom of this groove a cellular cylindrical rod, the notochord, is formed, which extends throughout the whole length of the future vertebral column. The anterior end of the notochord passes into the dilated cephalic end of the primitive groove, and corresponds in position to a part at least of the future basis cranii. Embryologists do not agree as to the distance to which this notochord passes forward in the base of the embryo skull. Mr. Huxley, grounding his statements mainly on the observations of Rathke, pronounces very positively that in all the vertebrata, Amphioxus only forming an apparent exception, it stops short immediately behind that part of the basis cranii which lodges the pituitary body.

Now, highly as everything should be valued which Rathke has written on developmental matters, yet it ought not to be forgotten that this position of his has not been allowed to pass unchallenged by embryologists of equal, and of almost equal repute. Thus Reichert, the eminent professor of anatomy in the University of Berlin, states that it passes at an early stage of development into the frontal region, and Kölliker also has observed it to reach farther forward than Rathke allows. In that very remarkable fish, the Amphioxus, in which the cranium remains membranous throughout life, the notochord extends almost to the anterior end of the head, far in front of the origins of the olfactory and optic nerves, and therefore beyond the region which would correspond to the pituitary fossa. The very striking exception which this fish affords to the universality of Rathke's proposition, may well make us pause and ask if our investigations into the mode of development of the vertebrate cranium were more extended than they have as yet been, might not other animals be found in which similarly well-marked exceptional arrangements exist?

From the sides of the "primitive groove" thin membranous

* Subsequently published in detailed abstract in the 'Edinburgh New Philosophical Journal,' January, 1857.

laminæ, "the dorsal laminæ," grow up, and gradually inclining inwards coalesce by their edges in the middle line. They form the foundations of the lateral walls of the skull and spinal column, and they assist in enclosing the spaces known as the cranial cavity and spinal canal.

The notochord then becomes surrounded in its whole length by a gelatinous investing mass which gives off anteriorly two bands, the "trabecula cranii." These are prolonged forwards, and, according to Rathke, embrace the pituitary fossa, and extend as far as the region in which the ethmoid bone is subsequently developed. Cartilage is then formed in this investing mass in by far the greatest majority of crania, and this constitutes the cartilaginous base of the skull and the bodies of the different spinal vertebræ. Mr. Huxley strongly insists on the essential difference in the mode in which this chondrification of the investing mass takes place in connection with that part of the notochord which corresponds to the spinal column, and that which lies in the basis cranii. In the former, he states a separate nodule of cartilage is developed for each of the bodies of the future vertebræ, whilst in the latter a continuous bar of cartilage is formed which never exhibits any transverse division or segmentation. And with this difference in the mode of chondrification he considers that the skull and spine at once begin to diverge from each other in their mode of development, each putting on its own special characters, each pursuing its own road to its final construction. But we may here pause and ask, are our inquiries into the "history of development" so far advanced—established on so sound a basis—as to permit us to accept, as unconditionally as Mr. Huxley would wish us to do, the primary continuous nature of the cartilaginous bar in the basis cranii developed in the investing mass of the notochord? Is its non-segmented nature to be looked upon as an ultimate fact in development? For our own parts, we doubt much if the subject as yet admits of so sweeping a conclusion to be drawn. But if we put altogether on one side these doubts which we have just raised, and accept the statement as a fact in development, what value are we to attach to it as an indication that, at this stage, the skull and spinal column diverge so strongly from each other that the one can be no longer regarded as a modified form of the other? Is it altogether to outweigh the generally admitted fact that the most perfect of all the forms of skull, *viz.* the osseous cranium, exhibits, like the spinal column, in advanced stages of its formation, undoubted evidence of segmentation, and in the primordial cranium it may be assumed that this segmentation is at least potentially indicated? And in the construction and arrangement of certain, at least, of these segments, there is an approximation to the plan of vertebral conformation, more especially in their central and neural elements, which at once appeals to the eye of the anatomist.

That the skull in its completely ossified state assumes a very definite segmentation is fully admitted by Mr. Huxley, and there runs throughout the lectures a very ingenious argument to show that in the whole series of osseous crania, from the pike to the man, three origi-

nally distinct segments may be traced. This concordance in the arrangement of the cranial bones, composing these segments, he considers, "places the doctrine of the unity of organization of the vertebrate skull upon a perfectly sure and stable footing;" whilst from the considerations already advanced, as to the non-segmentation of the cartilaginous bar in the basis cranii, "the hypothesis that the skull is in any sense a modification of vertebræ is clearly negatived." The three segments, which Mr. Huxley traces throughout the series, are the occipital, composed of the basi-, ex-, and supra-occipital bones; the parietal, of the basi- and ali-sphenoids and parietal bones; the frontal, of the pre- and orbito-sphenoid and frontal bones. These segments closely correspond with the central and neural portions of the occipital, parietal, and frontal vertebræ of Oken, Owen, and some other morphological anatomists. But we would ask, is it not possible to trace a still greater number of segments—whether we call them vertebræ or not, is of little consequence to this part of our argument—in the cranium? Mr. Huxley does not, in the above generalization, limit his segments to the region in which, or to the parts of the skull in relation to which, on his own showing, the notochord is confined. But, by accepting a presphenoidal segment, he admits of a cranial segmentation anterior to the pituitary fossa, *i.e.* in front of the spot where the notochord, as he contends, terminates anteriorly. Now, if the proposition be granted that the principle of cranial segmentation is not necessarily limited to the region of the notochord, but is applicable to the primordial cartilaginous cranium generally, we see no reason why, in those cases in which the structure and development of the skull admit of it, a still greater number of segments should not exist, ethmoid, vomerine, or even rhinal, as the case may be. We may illustrate this by a reference to the mammalian head. In the head of the mammal alone the nasal cavities are fully completed. And there enters, in a most important manner, into their formation, a series of cartilages, the nasal cartilages, which remain unossified. One of these, forming a part of the nasal septum, is the anterior prolongation of the basal portion of the primordial cranium, and ought therefore to be taken into consideration in coming to any conclusion as to the number and nature of the cranial segments. But the septal and lateral nasal cartilages, also, are quite passed over by Mr. Huxley, in his determination of the segments of the skull. Now this we cannot but think is a most important omission, and one, too, which, if supplied, might still more strongly serve to show, than has been done in these lectures, that, though there is in some respects a unity of plan in the cranial structure of the pike and the man, yet that there is in others "a no less marked diversity, each type exhibiting structures and combinations peculiar to itself." If the reception of a rhinal and a vomerine segment be objected to on the ground that they bear no relation to the neural axis, and differ in this, as in some other particulars, from the frontal, parietal, and occipital segments, it may be answered that at the caudal end of the spinal column great modifications in the form and composition of the vertebral segments often occur; modifications so great that the segment is often reduced to a

mere centrum, and its correlation with the nervous axis completely lost.

Mr. Huxley has devoted much care and labour to the determination, throughout the vertebrate series, of the bones which are homologous to the petromastoid portion of the human temporal bone, and the mode of their development. Partly by a critical inquiry into the almost forgotten researches of Kerckringius and Cassebohn, and partly by the more recent observations of Meckel, Hallmann, and himself, he has shown that it ossifies from three distinct centres, to which he has given the convenient terms of pro-otic, opisthotic, and epiotic bones. These bones enclose the organ of hearing and "are very generally represented, sometimes in a distinct form, and sometimes coalesced with one another, or with other bones, throughout the series of skulls provided with cartilage bones; and the pro-otic especially is one of the most constant and easily identifiable bones throughout the series of vertebrate skulls."

He does not allocate these bones, either in their separate or conjunct capacity, to any of the cranial segments, but regards them, like the osseous chambers of the olfactory organs, as bony capsules interposed between the arches of the segments. Their true morphological position may, however, be still held to be an open question. For they are developed in cartilage which forms a fundamental part of the primordial cranium, and, as such, it may be and has been argued, both by Carus and Goodsir, that they should have a place amongst the cranial segments.

In studying the morphological relations of the inferior, or, as they are sometimes called, hæmal arches of the cranium, it is of great importance that the nasal cavities should be carefully examined and the position of the nostrils determined. Great weight was attached to these points by Mr. Goodsir, in one of the memoirs already referred to, and we find that Mr. Huxley has also carefully entered into the subject. It has now been satisfactorily determined that the posterior nostrils in the mammalia are openings of a totally different character from what are called the posterior nares in a bird, an amphibian, a snake or a lizard. In a man, for example, the nostrils open posteriorly behind the palate bone, whilst in the other animals named, they open in front of those bones, between them and the maxillæ, and cannot therefore be regarded as homologous apertures.

The nature of the mandibular and hyoidean arches, situated behind the orifice of the mouth, has always been a difficult problem for the morphological anatomist. The embryological researches of Rathke and Reichert have done much to clear up many of the obscure and complex questions involved in their investigation. Many sound morphological data were also furnished by Mr. Goodsir, both as to their relation to the cranial segments, and the homology of their constituent elements. With much that Mr. Huxley has written we are disposed to coincide, though we confess ourselves unable to accept all his propositions regarding these arches in the present somewhat uncertain state of our knowledge of their mode of development.

Although much has been done in these lectures to endeavour to supply an exact conception of the morphology of the vertebrate cranium, yet the author has evidently been unable to find a place for many of the bones existing there. We may mention, amongst others, the bones marked 1, 2, and 3, in the pike's skull, the supra-orbital and sub-orbital bones, and the transverse bone, the morphological position of which he leaves quite undetermined. Looking then at these and other residual quantities still unaccounted for, the anatomist cannot accept, nor do we think it is intended by Mr. Huxley that he should accept, many of the statements advanced in these lectures as furnishing a final settlement of that "much vexed question," the morphology of the cranium. There is much work yet to be done before we can hope to arrive at anything like a definite conclusion respecting it.

The lectures on the vertebrate cranium ought, however, to be read and carefully thought over by every anatomist, not merely because they record the opinions of so distinguished a teacher as Mr. Huxley, but because, from the singularly lucid way in which one of the most complex subjects in the whole range of anatomical science has been treated, they may well serve as a model to be studied by future writers.

We have felt justified in bestowing a large amount of space and consideration upon Professor Huxley's book (which should, in reality, have formed two distinct works), because we believe it will take a high place in the classical scientific literature of our country, and will be handed down to posterity as one of the most comprehensive treatises on some at least of the subjects with which it deals; but along with its valuable information, and excellent illustrations, it will also transmit the fact, too well known in our day, that its author entertains feelings of bitter hostility against his most eminent contemporary, Professor Owen, for there is hardly a chapter in the work in which these feelings are not manifested.

It is, no doubt, true (and is very much to be regretted), that in Professor Huxley's earlier days, and even more recently, he was pained by unfair criticisms upon his anatomical investigations, criticisms which were all the more ungenerous, because the object of them was then a young man struggling for a position amongst men of science; but is it any more creditable to retaliate upon his commentator, by characterizing his mistaken views as mendacious?

It matters little to us, whether or not the strife continues; and as far as the public are concerned, they either take it as a matter of course that Professor Owen will be attacked whenever Professor Huxley speaks or writes; or they crowd to the lecture hall with the same feelings as they would go to witness a prize fight; all we can say is, that it imparts to the non-scientific world a false estimate of the spirit which exists amongst scientific men, a very false estimate indeed, and what chiefly concerns us as reviewers is that it does great permanent injury and reduces the intrinsic value of an author's works, for it is difficult to accredit a writer with strict impartiality, who cannot exercise a little control over his feelings. These remarks are made in the most friendly spirit; and we hope shortly to have from the pen

of the author a work of equal merit, without even this one serious defect. We have already spoken of the value of Professor Huxley's illustrations, and now conclude our notice with a word of praise to Mr. Wesley, the artist, for the excellent manner in which those illustrations have been transferred to the work itself.

ATHEISM AND SCIENCE.*

The extraordinary author of the extraordinary book before us says, quoting "Hirschel," that "nothing is so improbable but a German will find a theory for it," and he has favoured his readers with a most striking example of that truth in the publication of his own atheistical and materialistic theories, which are founded, as he believes, upon the newest discoveries of natural and physical science. We should certainly have allowed his book to run its course unheeded, without affording him an excuse for adding another to the four prefaces in which he defends himself against the attacks of his persecutors, were it not for another truth that it contains—namely, that "the scientific agitation in regard to the question discussed is daily spreading, and becoming, without exaggeration, a sign of the present time."

The inquiry is, indeed, spreading most rapidly, not strictly speaking as an "agitation," for those who agitate are for the most part men of limited knowledge and of no influence in society, and the bigotry of narrow theologians effectively prevents men of high eminence in science, who hold temperate philosophical views, from openly expressing their opinions. The effect is, that a substratum of materialism and atheism is silently forming beneath the visible surface of intelligent society, and such works as this, or others of a less offensive character, are the unhealthy eruptions whereby the disease is made manifest.

We give prominence to the present work in the hope, first, that it will awaken in teachers of religion an anxious desire to possess accurate information on all scientific subjects which have a bearing on theology, or where it is not possible for them to devote the necessary time to such a study, that they may be induced to seek the co-operation of talented *savans*, instead of regarding them with distrust, or driving them into open antagonism by stigmatizing their honest labours in the cause of truth as deeds of evil; and in the next place, we desire to show our intelligent men of science how necessary it is to be cautious in giving utterance to philosophical speculations which are liable to misconstruction, though they may appear to be based upon scientific data; and to satisfy them that the men who affect atheism are now, as heretofore, persons who possess indeed a larger amount of gene-

* 'Force and Matter.' Empirico-philosophical Studies, intelligibly rendered, &c. By Dr. Louis Büchner, President of the Medical Association of Hessen-Darmstadt, &c., &c. Edited from the last edition of 'Kraft und Stoff,' by J. Fredk. Collingwood, F.R.S.L., F.G.S. Trübner & Co.

XUM

ral knowledge than those whom they seek to pervert, and quite enough sophistry to turn what they do know to bad account; but whose theories will not bear a critical examination, and whose practice can hardly be expected to be such as would recommend them to honourable men, or even to justify their admission into respectable society.

We have deemed these prefatory observations necessary before acquainting our readers with the nature and contents of a work, the perusal of which has been a most painful task to us, although we are ever ready to listen to the theories of scientific sceptics, and to allow them a large share of liberty in their speculations.

The following is the philosophy of the author and of his school:—Matter and Force are both immortal. The forces are inherent, or immanent in matter; they are, in fact, properties of matter. Matter is infinite; it is "dignified," for "it is the vehicle of all mental power, of all human and earthly greatness."

The laws of nature are immutable and universal. "Spirit and nature are the same," and "reason and the laws of nature are identical."

The worlds were formed "from a shapeless mass of vapours by the rotary motion of specks, so as gradually to have become condensed into compact globular masses," and are kept in constant and regular motion by the law of attraction.

The idea of an "external personal" activity, or God, is excluded "by the many irregularities, contingencies, &c., in the economy of the universe and individual bodies." If there had been a personal creative power, "there would not have been these enormous waste useless spaces in which but here and there suns and planets swim, floating about as imperceptible points;" the moon would have had an atmosphere and water; the planets would have been all the same size; and, asks "Hudson Tuttle," an eminent atheistical authority, whose opinions are frequently quoted, but of whose writings we cannot help pleading ignorance beyond what we find in this book,* "Why did the Creator give rings to Saturn, which, surrounded by his eight moons, can have little need of them, whilst Mars is left in total darkness?" All changes in the Earth have been produced by ordinary known physical forces during enormous periods of time, and it would be absurd to suppose that an arbitrary Almighty power "should require such efforts to attain its objects."

When the Earth had cooled down from the state of a "fiery globe," and the watery vapours were precipitated upon it, then "organic life developed itself." In the lowest deposits in which organic forms could have existed, we find their traces, and they became developed with each ascending stratum, until in the uppermost man appears, "the climax of gradual development"—"Man is descended not from several, but from very many pairs."

There is no such thing (in the abstract) as design in nature, nor are there any traces of an active creating hand. Our reflecting reason

* It appears he published the 'History and Laws of Creation,' in 1860, but we are not told who and where is the publisher, or we might have included the work in this notice.

is the sole cause of the apparent design. "There is no natural contrivance which might not be imagined more perfect than it is;" the order which "appears to us as produced by design," "was established by natural conditions." "Nature has produced a number of beings and contrivances in which no design can be detected, and which are frequently more apt to disturb than to promote the natural order of things."* Very little has yet been done to show the use of such "troublesome and disgusting creatures" as "dangerous reptiles and insects."

It is a mistake to suppose that nature has done anything in anticipation of the advent of man, "there are no ends which nature had in view to favour a privileged being. Nature is an end in itself."

The brain is in all animals the seat and organ of thought. The two are inseparable, and the brain is proportioned in size, shape, and structure, to the magnitude of its intellectual functions. "Mental function is a peculiar manifestation of vital power, determined by the peculiar construction of cerebral matter."

The peculiar chemical constituents of the brain, and its complicated structure, account for the remarkable functions it performs. It is easy to prove that mind and brain are inseparable, for accidents to the brain cause a concomitant imperfection of the mind, and the entire removal of the brain leaves the body alive, but the soul is gone.

"Thought is a motion of matter," and the brain is "only the carrier and the source, or, rather, the *sole cause* of the spirit or thought. "The senses are the source of all truth and all error, and the human mind is a product of the change of matter."

The souls of brutes differ from those of men in quantity, not in quality. The term "instinct" is a misnomer, and all so-called instincts are the consequences of "deliberation, the result of comparisons and conclusions." The transition from the lower animals to man is imperceptible; the Crétin is *below* the brute, and the Negro has all the "characteristic peculiarities of the Ape."

Language is *not* a distinctive feature in Man. The lower animals can speak, some by signs, others by sounds, whilst there are whole races of men who are no better than animals in this respect, speaking more by signs than by articulate sounds. Educability is not peculiar to man; it is chiefly the difficulty of communication which prevents animals from rising in intelligence. The soul has no "personal continuance," for thought cannot exist without brain, and with the dispersion of the "force-endowed materials, and their entrance into other combinations, the effect which we call soul must disappear." This doctrine cannot be objected to on the ground that the "thought of eternal annihilation is revolting to the innermost feelings of man," for "the thought of an *eternal life* is more terrifying than the idea of eternal annihilation." Neither is there anything to be gained by a continuance of life.

* We cannot refrain from quoting here a sentence of the author's, from another part of the work (p. 251):—"Exact science inculcates modesty." This expression is, however, used in the chapter of "concluding observations," and perhaps it was a conclusion at which the author had not arrived at so early a stage of his investigations.

"Perfect truth would be a sentence of death for him who has acquired it, and he must perish in apathy and inactivity." The idea of a "Free Will" is based upon superficial observation of nature; if man have a free will, it is of the most limited kind. His will is dependent upon "a fixed necessity," upon climate; upon "intellectual individuality" which prescribes to him "his mode of action with such force that there remains to him but a minute space for free choice."

This is, we believe, the gist of the author's philosophy, and it cannot be denied that he not only possesses a large amount of superficial information, but that here and there he has displayed considerable tact in dovetailing it into his theories. Nevertheless, we cannot find that these are based upon the revelations of modern science, and furthermore, if the numerous contradictions and inconsistencies in which his work abounds, and of which examples will be given hereafter, and the confusion of ideas that may be found in almost every page may serve as our guide, we are justified in believing that the author is himself far from comprehending his own teaching.

Let us examine one or two of the fundamental principles on which his whole doctrine is based.

All the "so-called imponderables, such as light, heat, electricity, magnetism, &c., are neither more nor less than changes in the aggregate state of matter;" in other words, they are modes of motion; motion is, of course, a force, and "there is not a single case in which force" "can be born or annihilated." But motion, according to the author's views (in common with all force), is "immanent in matter;" "the motion of matter is as eternal as matter itself," and finally, the laws of heat, light, &c., are "everywhere the same."

Now, if we liked to dogmatize, we should be quite justified in saying that "*empirical*" knowledge teaches us that force is not immanent in, but always, as far as we can judge, external to matter, and that all conversions of force as well as changes in matter are performed by a governing will, and guided by a reflecting reason, notwithstanding the existence of apparent exceptions to this rule in nature. On a limited scale human reason and human will are constantly bringing about more or less important changes of this kind, and we have the author's precedent for holding that we have "not merely the right but the duty, in accordance with the laws of induction, to infer the unknown from the known, and to maintain that a universal law which is true for a portion of organic phenomena is applicable to all." *

However, we will not be so ungenerous as to turn the author's weapons against himself and assume to be his teacher; we will rather sit meekly at his feet, and be attentive listeners and learners. Let us hear how his "matter" and its "immanent forces" have comported themselves from eternity.

Matter, then, began its operations "by the rotary motion of specks," and all the modifications of motion which subsequently ensued are "merely the result of a single universal law of nature—*the law of attraction.*"† "Why matter assumed a definite motion at a

* P. 221. † P. 51.

definite time, is as yet unknown to us," but it is probable that the investigations of science will give us a clue to this mystery.*

It may be evidence of great obtuseness on our part, but we confess that the author travels too fast for us, for we cannot understand how, if matter be eternal, and motion, which is inseparably united to it, be eternal also, matter can ever have *begun* to move; and how it is that the "law" of attraction was not always at work. According to the author's views, "matter and force" must have had the power within themselves to commence a series of operations which have resulted in the formation of the worlds, and when they made up their mind to start, they did so; but we should be sorry to press even this moderate approach to a theological creed, because "we should approach to pantheistic ideas," which the author places in the same category with the vain fancies of believers in a Deity. †

However, granted that eternal matter with its immanent eternal forces, and controlled by the law of attraction, *did* "begin" to bestir itself, what followed? The inorganic world developed itself, and all went on smoothly until it was necessary for nature's ends (by the way, nature has no ends, "it is an end in itself"—for the development of matter, then) that organic life should appear. How was this brought about? Well, when the "fiery globe" was cooled down, and the vapours had settled upon the Earth "with the appearance of water, and as soon as the temperature permitted it, organic life developed itself."

And why not? "Where air, heat, and moisture combine, there appears sometimes in a few moments an innumerable world of singularly-shaped animals, which we term infusoria."‡ This is what is called "spontaneous generation," which "signifies the production of organic beings without previously existing homogeneous parents or germs, merely by the accidental or necessary concurrence of inorganic elements and natural forces," &c.§

And now we have presented to us evidences not only of the author's candid and impartial mode of inquiry, but also of the profundity of his research, and of the originality of his views.

"*Generatio æquivoca*" is not yet quite a settled question; Pouchet and Pasteur, Wyman, Jolly, Musset, and a crowd of investigators are still actively engaged upon the inquiry, but sufficient is ascertained to satisfy the author that this kind of generation "does not exactly possess a scientific basis," and that "*omne vivum ex ovo*" is becoming the order of the day. Let not this crude, unsettled state of science, however, afford any encouragement to believers in a Deity and a creation. "We might answer these believers, that the germs of all beings had from all eternity existed in universal space, or in the chaotic vapours from which the Earth was formed; and these germs, deposited upon the Earth, have there and then become developed, according to external necessary conditions. The facts of these successive organic generations would thus be sufficiently explained."‖

There, reader, that *is* a theory founded upon "a scientific basis."

* P. 53. † P. 87. ‡ P. 66. § P. 69. ‖ P. 71.

Some over-curious spirits might, perhaps, inquire what could have been going on in the "chaotic vapours" to produce these germs before their "specks" began to rotate, but that would be hypercritical, and we feel sure that all naturalists will be grateful to Dr. Büchner for this lucid exposition of his views concerning the origin of living organisms, more especially the advocates of spontaneous generation, the believers in the creation of foraminifera from "ooze," and in the spontaneous development of the gigantic reptiles of old, from the muddy beds of rivers, a theory which, by the way, appears to have the author's valuable but qualified support.* And now, organic life being once established, development proceeds actively. It is, "perhaps, morally certain that a spontaneous generation exists, and that higher forms have gradually and slowly become developed from previously existing lower forms, always determined by the state of the earth, but without the immediate influence of a higher power."†

Here, too, a little difficulty presents itself. The revelations of science are certainly tending in the direction here indicated (leaving out the question of the higher power); but still the author feels that he would appear ignorant in the eyes of men of science if he did not acknowledge that the question is not yet *quite* decided; so he reminds his readers that external influences upon animals are, "though considerable, yet insufficient to change their specific form." The alternation of generations, the metamorphoses of insects, are evidences which may be adduced in favour of his theory; but even these phenomena, although they represent "a real change of the species," are limited. There has, however, been "one important and pregnant discovery" which should suffice to convince the most sceptical. It was made, not by an unknown observer, but by one of the greatest physiologists of the day; not by a sceptic, but by a "believer," and it was "a discovery which staggered its orthodox discoverer."‡ Johannes Müller discovered "a generation of snails in *Holothuriæ*," and "*Holothuriæ* and snails belong to different divisions in the Animal Kingdom." This discovery "removes any doubt as to the possibility of a permanent development of one species from a different one."

This is the kind of *canards* upon which the author bases his views as to the processes by which nature, as we now see it, has, "without the immediate influence of a higher power," called itself into existence, or, to speak more correctly, developed itself from vaporous masses; and we shall now cull from his book a few of his thoughts regarding the behaviour of nature whilst engaged upon its important task, so that we may be enabled to judge whether or not the intervention of any "higher power" was necessary for the perfection of the universe. But as our space is limited, and our criticisms upon this contribution to our scientific literature, however remarkable it may be, cannot be allowed to extend to an unreasonable length, we will at the same time extract a few of the author's ideas on other difficult subjects, and our readers will have an opportunity of judging how clear is the conception he has formed of them himself, and what deference he pays to truth and reason.

* P. 77. † P. 72. ‡ P. 80.

"Empirical natural science," he tells us, "has no other object than to find out the truth, be it according to human notions, consolatory or the reverse, beautiful or ugly, logical or illogical, rational or absurd, necessary or contingent."—(Cotta.) *

This statement, with which the work closes, may possibly perplex some of our readers. Indeed, they may be disposed to wonder what other "notions" an atheist, a man "who considers transcendentalism an aberration of the human mind,"† can have of truth, excepting *human* notions, or how truth can be truth, if it be illogical or absurd; but this arises from their not fully comprehending the wisdom of the acts of "Natural Science." They shall now be enlightened.

"Nature is perfect in itself, being in its development governed by unalterable laws." (p. 88, Prof. Giebel, of Halle.)

"We find in the constant harmony of nature a sufficient proof in favour of the immutability of its laws." (p. 33, Tuttle.)

As "Nature does not act from a conscious design, but according to an immanent necessary instinct, it becomes obvious that it must be guilty of many purposeless absurdities." (p. 94.)

"Nature has produced a number of beings and contrivances in which no designs can be detected, and which are frequently more apt to disturb than to promote the natural order of things." (!) (p. 94.)

This will convey to our readers some idea of the author's "nature." Another word concerning his "matter and force."

"Matter must have existed from eternity, and must last for ever." (p. 12.)

"Force is a mere property of matter." (p. 4.)

"There exists a phrase, repeated *ad nauseam*, of mortal body and immortal spirit. A closer examination causes us with more truth to reverse the sentence." (p. 13.)

"Although the immortality of matter is now an established truth, the same cannot be said in regard to force." (p. 17.)

This seems a little contradictory; however, let us search a little further, that we may be enlightened.

"No force can arise from nothing." (p. 2., Liebig.) ‡

"Indestructible, imperishable, and immortal as matter, is also its immanent force. Intimately united to matter, force revolves in the same never-ending cycle, and emerges from any form in the same quantity as it entered." (p. 16.)

"No motion in nature proceeds from, or passes into, nothing." (p. 17.)

"Physics show that, as there was a time when no organic life existed on earth, so will the time arrive—no doubt an infinite and incommensurable period—when the physical forces now existing will be exhausted, and all animated beings plunged into night and death." (p. 105.)

* P. 258. † P. 253.

‡ The names of Liebig, Helmholtz, &c., will be found in this work, as observers from whom quotations are made in support of the author's views; but in justice to these great and honourable men, we deem it right to say that isolated expressions are perverted in their meaning, just as dishonest publishers sometimes revenge themselves upon critics, by snatching from their adverse reviews portions of sentences apparently laudatory.

Let us supply or rather bring down the corollary :—

"Force is a mere property of matter," and "indestructible, imperishable, and immortal, as matter is also its immanent force" (until it is exhausted, we presume).

And how is the universe governed ?

"The same materials and the same laws govern the visible universe," and "everywhere act in the same manner as in our proximity." (p 45.)

"The laws according to which nature acts and matter moves, now destroying, now rebuilding, and thus producing the most varied organic and inorganic forms, are *eternal* and *unalterable*." (p. 33.)

"There exists neither chance nor miracle, there exist but phenomena governed by laws." (p. 38, Jouvencel.)

"It depends on an accident whether or not they (natural objects) will enter into existence." (p. 90.)

A word concerning "vital force," and voluntary motion :—

"Vital force cannot be appealed to; that is scientifically dead." (p. xxvii.)

"The motion of what is called vital force, is now rejected by exact observation." (p. 215.)

"Mental function is hence a peculiar manifestation of *vital power*, determined by the peculiar construction of cerebral matter." (p. 125.)

When the embryo of man moves in the womb;

"These motions are involuntary, not determined by a mental act." (p. 159.)

But the mode in which "vibriones, microscopical animalcules of the smallest kind," of which a cubic line contains 4,000 millions; the mode in which these living atoms move, "leaves no doubt that they possess sensation and will." (p. 24.) (!)

Having shown (as he believes) that man has no "innate intuitions," the author proceeds to argue, that those who believe in a Deity on the ground that the idea is innate, have no foundation for their faith, and mentions some nations which are said not to have any conception of a God.

He also adduces as evidence that the "Indians in Oregon" have for their highest divinity "the wolf," which "seems, according to their descriptions, to be a hybrid of a divinity, and an animal;" * and that,

"Paul Kane describes the Indian Chinooks, like most red skins, to be without distinct religious sentiments. They ascribe everything to the Great Spirit; but this Great Spirit is, according to their ideas, a very vague being, and not the object of any worship." (p. 187.)

Weighty evidence against "innate intuitions," and "*the Existence of a Deity.*" There is more of the same kind in the same chapter.

Amongst his authorities for disbelieving in the immortality of the soul, are, "the celebrated Chaumette," who, during the French revolution, "erected in the cemeteries statues representing Sleep;" Lessing, who thought it must be a great "ennui" to live for ever; Danton;

* P. 185.

the Jews before the Babylonian exile (how the race must have degenerated according to the author's views!); Shakespeare, (!)* Pliny, Homer, Simonides, Seneca, Pomponatius, Frederick the Great (the predecessor of kings who rule by divine right!) and "the enlightened of all nations and times,"† amongst whom the "dogma of the immortality of the soul has ever had but few partisans." On this ground then, if on no other, Messrs. Büchner, Tuttle, and Co. may be added to the above authorities, and included amongst the "enlightened." But it appears from Preface No. IV. that some of the author's critics are not disposed to admit him into this rank of society, and that others go still further in their malignity, and have attempted to damage him in public opinion by casting suspicions upon his moral character.

Not knowing anything of his private character, we cannot, of course, express an opinion on so delicate a matter; but we will allow the author to state his ideas of morals and morality; ideas which we presume to be held by all of like professions with himself.

"Science has no concern with morals." (p. lxv.)

"The person of the investigator, and that of his moral convictions, have nought to do with his investigations."‡ (p. lxv.)

"Annihilation, non-existence, is perfect rest, painlessness, freedom from all tormenting impressions, and therefore not to be feared." (p. 205.)

"Free will, if it exist, can only have a limited range." (p. 239)

"Man is free, but his hands are bound; he cannot cross the limit placed by nature." (p. 245.)

"Another (person) § *inclines to conscientiousness; he is just in all his transactions, and may put a term to his existence if deprived of the possibility of fulfilling his obligations.*"

Very convenient doctrines these for persons whose "cerebral matter" happens to be endowed with propensities to indulge in vices which do not come within the pale of the law, and who "act according to their impulses or habits," as all men do, in the author's opinion! ‖ No free will, and a kind of conscientiousness which causes men to put an end to themselves, and seek the haven of "perfect rest," and "freedom from all tormenting impressions," when they can't pay twenty shillings in the pound.

This is the morality of Atheists and Materialists!

That any human being endowed with reasoning faculties and possessed of a fair amount of information could have trusted himself to give utterance to such a tissue of contradictions and absurdities as are to be found in this book, and should attempt to pollute the scientific literature of his age with such trash as it contains, is explicable through the views which he entertains concerning a Deity; but whatever can have induced an Englishman, aspiring to a respectable position in the scientific world, a Fellow of the Geological Society, voluntarily to

* 195. "Thy best of rest is sleep,
And that thou oft provok'st; yet grossly fear'st
Thy death, which is no more!"

† 213. "*The Duke*," *in* '*Measure for Measure*.'

‡ This depends very much upon the notions which he has concerning *truth*.

§ We italicize these lines.

‖ Quoting Auerbach, p. 244.

sit down and translate a book full of blasphemy, to give his sympathies to a writer who sneers at all that the mind of civilized man has held sacred, who perverts scientific truth, and drags through the mire such honoured names as Liebig, Lyell, Darwin, Faraday, Humboldt, Flourens, Schiller, Shakespeare, Lessing, and the Scriptures, levying black mail upon them in support of his atheistical views; how he dares to print his name on the title-page as the editor, is quite incomprehensible to us.

We cannot but commend Mr. Collingwood's prudence in not "always" subscribing to the "alleged facts" contained in the work, and to the "inferences drawn from these facts," but we by no means envy him the great "pleasure" which he experiences in introducing the work to English readers; and whilst we entirely disagree with him as to the desirability of its being "admitted to the rolls of English literature," we feel sure that all classes of scientific readers, from freethinkers (in the more restricted sense of the term) to orthodox theologians, will pronounce it a vulgar, blasphemous book, full of absurd contradictions, and presumptuous, unscrupulous assertions, published, with its numerous prefaces, with a view to create a sensation, and the only persons to whom it will give unfeigned satisfaction are the small semi-educated sect of men calling themselves "Naturalists," or "Secularists," who will no doubt use it, as Dr. Büchner has attempted, to abuse science.

To us, the author appears to have done his very worst for science and for himself. Judging from observation and experience (and "whoever rejects experience rejects human conception" *), we shall expect him at some future time to be a rabid theologian; one who, if he had been an Englishman, would be found lecturing on Redemption in some obscure tabernacle, "all seats free, and discussion invited;" and infusing into his religious discourses about as much reason as he has thrown into his atheism.

We have no desire to be severe or condemnatory in our epithets, and shall content ourselves with saying, that if the author is sincere, and has undertaken a scientific expedition, it has been another illustration of the old German saying:—

"Es ging ein Gaenschen uber's Meer,
Und kam als Gans auch wieder her."

"A gosling crossed the sea, and a goose it returned."

The advantages which may arise from the publication of the work were referred to in our introductory remarks, and it is unnecessary to repeat them; but the moral it teaches, is one of the wisest that ever a wise man uttered, and we earnestly commend it to the consideration of the author and translator, and to all who feel disposed to sympathize with their doctrines. It was Lord Bacon who said, "A little philosophy inclineth man's mind to atheism, but depth of philosophy bringeth men's minds to religion."

* P. 253.

THE MICROSCOPE.*

If there be a philosophical instrument before any other that has exercised a beneficial influence upon modern society, it is the Microscope. It has lent an impulse to the study of Natural History, of which the results have been more striking than any recorded previous to its invention; and through its employment, man's acquaintance with the laws and operations of nature has in a very brief period increased in a degree almost miraculous. It has taught him to observe with greater care; to calculate with more accuracy; has opened out new fields for the exercise of the mental faculties, raising the sense of wonder and admiration whilst at the same time it cultivated the reason. To the artist and poet it has offered new scenes and themes in Nature; and, in other walks of life, has employed thousands of busy hands and brains. In its simplest form the manufacturer carries it in his waistcoat-pocket to examine the texture of his fabrics, the seedsman to inspect his seeds, and so in many trades; whilst the more complicated instrument has become almost indispensable to the higher professions—the surgeon, physician, and analytical chemist having recourse almost daily to its defining powers. Indeed, there is hardly a home where, in one form or another, the magnifying lens is not to be found; scarcely a cultivated family circle in which at least one member does not avail himself of its use.

And how is it that even as a mere means of recreation, the microscope should have acquired a position in the homes of men which no other instrument has been able to command? The revelations of the Telescope are certainly far grander, and the performances of the Magic-lantern more amusing; and yet, for every one of these instruments, we may count in the houses of the intelligent classes at least twenty microscopes. It is because the last-named instrument brings us into nearer relations with that mysterious influence which we call Life—an influence which human curiosity has endeavoured from time immemorial to fathom, revealing to our gaze the hidden springs of vital action in living objects with which our acquaintance was previously but superficial; and exhibiting new scenes from animated nature, where we were before accustomed to believe only in the existence of inorganic substances influenced by physical forces. For a long period indeed, whilst the possession of a microscope was a privilege accorded only to a few professional men, and was often employed by these rather as a means to mystify than to enlighten, the doings of the microscopical world were regarded as being beyond the ken of ordinary mortals; and even within the last few months we were informed by a friend, who had deputed us to select a microscope for the use of his family, that his gentler half entertained conscientious scruples with respect to the ad-

* 'An Elementary Text-book of the Microscope; including a Description of the Methods of Preparing and Mounting Objects,' &c. By J. W. Griffith, M.D., F.L.S., M.R.C.P., conjoint author of the 'Micrographic Dictionary.' J Van Voorst.

'The Preparation and Mounting of Microscopic Objects.' By Thomas Davies. R. Hardwicke.

mission of such an instrument into her house, as she believed it was not the intention of the Creator that we should see the things it revealed, or He would have enabled us to do so with the naked eye!

It may be considered ungallant to criticize the views of a lady, but we cannot help saying that such a remark exhibits a great want of confidence in the Creator, who has not only enlightened us by means of the microscope on many obscure points in Natural History, instructed us how to detect that adulteration which, like a false balance, must be "abomination to the Lord," and enabled man to prolong the precious gift of life; but has taught us through this medium that His relations are as intimate with the minutest objects of His creation as with the highest; for, as the telescope has revealed to us His power in the distant worlds, so has the microscope proclaimed his goodness in the water-drop!

It is not surprising, then, that the numerous practical uses of the instrument, coupled with its efficacy as a means of educating the mind and of pleasing some of our highest intellectual tastes should have caused it to be regarded with such great favour, and should have led to its extended manufacture; and it *would* have been a matter of astonishment, if, with its increased fabrication and employment, the world had not been favoured with numerous works upon the principles and mode of its construction, and the methods of its application. This has followed as a matter of course, and each season produces a number of works of more or less merit, and tending in a greater or less degree to diffuse the love of microscopical studies.

Amongst the treatises for the use of advanced students, the foremost in rank are Dr. Carpenter's 'Manual,' and the 'Micrographic Dictionary' of Dr. Griffith (the author of one of the works about to be considered) and the late lamented Professor Henfrey. Many others of great merit might be added; but if we were asked to recommend an elementary text-book for a young beginner, or for the use of amateurs, we confess that we should have great difficulty in selecting one that might fairly be considered complete in itself.

Even in the present incipient stage of the science, it would be difficult to embrace all that is desirable in such a treatise. A few hints as to the selection of an instrument, with an account of its chief parts, and how they should be manipulated; directions for securing and mounting useful objects in the most approved manner; a clear description and systematic classification of easily-attainable objects in the inorganic and organic realms of nature, to lead the young student unconsciously from "philosophy in sport" to "science in earnest," and cause a pleasant diversion to become the foundation of a lifelong study,—these are the desiderata in an elementary text-book; and such a treatise, we believe, has yet to be composed.

But, although it is by no means perfect, the one before us, written by the surviving author of the 'Micrographic Dictionary,' commends itself strongly to our favourable notice. It bears the impress of thoughtful care, extended knowledge, and a thorough acquaintance with the subjects of which it treats. Its contents are scientifically arranged, and the reader is made conversant with the elements of every

branch of Natural History from which the illustrations are drawn; indeed, as far as it goes, it is admirably written, and we feel sure that every large-minded microscopical writer or observer will agree with us, when we pronounce Dr. Griffith's little work the best of the kind extant. Its chief merit consists in its truly educational character, which raises it above many of those brochures whose sole object seems to be to afford amusement for the hour; but this feature does not by any means render it the less interesting and attractive.

If we take, for example, Chapters III. and IV., we find that the beginner is taught by means of practical illustrations, not alone the character of "vegetable elements and tissues," but of the organs and functions of plants; and if he takes care to seek out the objects recommended for his observation, he cannot fail to become acquainted with the nature and functions of leaves, stems, roots, flowers and seeds, and with the leading phenomena of fertilization. But our readers may be disposed to think that, in order to instil into the mind of the tyro such an amount of general information, the author must have recourse to technical language, and must avail himself of illustrations difficult of access to the student. By no means; in all such matters the author has smoothed the way for the uninitiated, the burthen of whose labours he has to a great extent borne himself, employing the clearest language, explaining every technicality, and, above all (and this is a great merit in the little work), availing himself, not of the old stock subjects for illustration, but of substances well known to the least informed, and readily procurable by every one.

Here, for example, are the teachings of a cell from the pulp of an apple:—

'Cell-Contents.—In most cells, especially when young, a minute, rounded, colourless body may be seen, either in the middle or on one side, called the *nucleus*. This is very distinct in a cell of the pulp of an apple (Pl. 1, Fig. 2*b*); and within this nucleus is often to be seen another smaller body, frequently appearing as a mere dot, called the nucleolus.

'The nucleus is imbedded in a soft substance, which fills up the entire cell (Pl. 1, Fig. 20); this is the protoplasm (πρῶτος, first, πλάσμα, formative substance). As it is very transparent it is readily overlooked; but it may usually be shown distinctly by adding a little glycerine to the edge of the cover with a glass rod, when it contracts and separates from the cell-walls, as in the lower cell of Fig. 2. The protoplasm in some cells is semi-solid, and of uniform consistence, while in others it is liquid in the centre, the outer portion being somewhat firmer, and immediately in contact with the cell-wall. In the latter case it forms an inner cell to the cell-wall, and is called the *primordial utricle*. The terms "protoplasm" and "primordial utricle" are, however, used by some authors synonymously.

'The protoplasm is the essential portion of the cell, and it forms or secretes the cell-wall upon its outer surface in the process of formation of the cell, considered as a whole. It is also of different chemical composition, from the cell-wall being allied in this respect to animal matter.'

Thus simply, and with the aid of the cell from the pulp of an apple, does the author convey to his uninformed readers the chief facts in regard to one of the most difficult questions in vegetable physiology; and as he has drawn upon the apple for his illustration in this instance,

so he employs the commonest, but by no means the least interesting and attractive objects throughout his survey of organic nature.

From the vegetable kingdom we have the leaf of a geranium, the starch granules of cereals, or of the potato; the stalk of garden rhubarb, with its exquisite structures; sections of deal and holly; hairs of London pride; pollen grains of the crocus, primrose, and sunflower; sting of the nettle; petals, sepals, and other parts of the common chickweed; sections of mustard-seed, &c.; and again, the best known ferns, such as Polypodium and Scolopendrum vulgare, the most familiar mosses, lichens, and sea-weeds, a few of the commonest desmids and diatoms.

From the animal kingdom, which is by no means so largely illustrated, we have the blood-corpuscles of man, of the fowl, &c.; hairs of men and of mice; fibres of flax, silk, and feathers; scales of familiar fishes; heads and weapons of offence of *too* familiar insects; cilia from the gills of the oyster; along with examples of the most widely-distributed Rotifera, Infusoria, and Entozoa: all the objects enumerated, with many more (in all 451 figures) being grouped in twelve plates, well coloured after nature, and engraved by a new microscopical artist, Mr. W. Bagg.

As we have already stated, however, the little work is by no means perfect, much as it deserves our commendation. If, instead of devoting by far the greater portion of his volume to the vegetable kingdom, of attempting to explain the more obscure phenomena of magnification, polarization, &c., the author had favoured his readers with a few more original drawings of the minute forms and microscopical features of animal life, some of the most important of which are left quite unrepresented, whilst those selected are by no means the most beautiful; and if he had appended a chapter on crystals and other inorganic objects, his work would have been greatly benefited, and it would not have been open to the objection that it is rather a guide to the microscopical study of organic nature, than what it professes to be, namely, a text-book of the microscope generally.

We leave these hints with the able author in case a second edition is called for, as no doubt it soon will be, and meanwhile we recommend the book as a fresh, useful little work, full of accurate original delineations of well-classified microscopical objects in organic nature, and not as we sometimes find to be the case in such treatises, a mere patchwork composed of the researches of other men, and with (made up by the help of scissors and paste) a heterogeneous jumble of drawings, correct or otherwise, not one tithe of the objects which they represent having been seen by the authors who profess to describe them.

There is, however, one class of persons to whom the little book will appear very imperfect,—namely, to those who desire, not alone to inspect, but to prepare and mount objects for preservation. The chapter on this subject is very meagre; and to readers thus inclined we have no hesitation in recommending the second work of which we give the title. It must be clearly understood, however, that we have not placed them thus with a view to institute a comparison between them, inasmuch as Mr. Davies's book is devoted solely to the mount-

ing of microscopical objects and makes no pretension to scientific knowledge beyond what is immediately necessary for that purpose.

It is an unassuming little brochure, without illustrations and by no means attractive in appearance, but is composed by an author who appears as modest as he is enthusiastic, and contains, besides his own experiences in preparing and mounting objects, the most approved methods of many of our most eminent microscopists, of Dr. Beale, Dr. Golding Bird, Dr. Carpenter, Mr. Rylands, Mr. Hepworth, &c.; and it instructs the student, not only as to the best method of mounting objects, but how to select those which are the best suited for permanent preservation. It wants a table of contents, and would suffer nothing if the head-lines of the pages were a little more explicit, instead of being, as at present, a mere repetition of the title of the work from beginning to end.

We offer no apology to our readers for having occupied so much of their attention with an account of these two little works, for they represent what is becoming one of the most important intellectual pursuits of our middle and upper classes, and is happily supplanting in the lives of the growing youth of our day many frivolous and mischievous practices. Hundreds there are, both young and old, who would like to follow some intellectual employment during their leisure hours, if they but knew which to select and how to proceed; to such, then, we would recommend a good microscope, and its employment under the guidance of the two little works of which we have here endeavoured to give an unprejudiced account.

THE OPHTHALMOSCOPE AND OPHTHALMOSCOPIC PHOTOGRAPHY.*

In the former part of this number of the 'Journal of Science,' we have given a sketch of the history and uses of the Ophthalmoscope, the practical application of which the two publications whose titles are named at the foot are intended to forward. Mr. Hogg enters fully upon the principles upon which the instrument is formed, the best method of using it, and points out the changes in the fundus of the eye which are discovered by it.

From his previous writings on the microscope, and his familiarity with the laws of optics, the author was well qualified to appreciate the importance of the ophthalmoscope; as he was one of the first to direct the attention of the medical profession to the subject, so he has been one of the most diligent students in this country in its application. The first edition of this book in 1858 was a small, unpretending

* 'A Manual of Ophthalmoscopic Surgery: being a Practical Treatise on the Use of the Ophthalmoscope in Diseases of the Eye.' By Jabez Hogg. 3rd edition, re-written and enlarged. 8vo. Churchill & Sons.

'A New Ophthalmoscope for Photographing the Posterior Internal Surface of the Living Eye, with an Outline of the Theory of the Ordinary Opthalmoscope. By A. M. Rosebrugh, M.D.

volume, while this last edition has not only expanded into a goodly octavo volume, but the contents have increased in value, as the subject has advanced in importance. Those who are interested in the matter merely as one of science, cannot do better than consult Mr. Hogg's book, as they will find in it all that they need; while those professional men who desire to use the instrument and become qualified to estimate its value, will do well carefully to study its contents; for, as it is one of the latest, so it is one of the most complete, publications in the English language on the subject. Its illustrations, woodcuts, and coloured lithographs of the interior of the eye in health and disease cannot fail to be of considerable use to the beginner. These coloured views are not only more numerous, but also better executed than those in the first edition of the work; still we would call the author's attention to the magnificent illustrations recently published by Liebreich in the 'Atlas d'Ophthalmoscopie,' which as works of art have never been exceeded in beauty of execution, as well worthy of rivalry, when another edition of his book is called for. We well know the difficulty and cost attendant upon the illustrations of such a character, but we cannot doubt that artists in England may be found who are equal to the task, and the extra outlay would be well repaid by the greatly-increased value of pictures which shall equal in delicacy and beauty the original structures which they represent.

The pamphlet by Dr. Rosebrugh is a reprint, from a Canadian Journal, of a paper read by him in January last before the Canadian Institute, in which he describes a new ophthalmoscope he has lately invented for obtaining a photograph "of the posterior internal surface of the living eye." It would be very difficult to convey a clear idea of the apparatus without diagrams. It, however, essentially consists of a modified ordinary photographing camera, in which the tubes and lenses are so arranged, that near their juncture is placed a polished plate of glass, with parallel surfaces, inclined at such an angle to the tubes that a part of the light entering by the illuminating tube is reflected, at right angles to its original direction, into the dilated pupil of an eye, from which it is again reflected upon the back of the camera, when, instead of the image being received upon an ordinary ground-glass screen of a camera, it falls upon a properly sensitized collodion glass, upon which, by about five seconds' exposure, a negative picture is impressed. This negative is then used in the ordinary way for printing the positive photographs.

Though Dr. Rosebrugh does not yet appear to have succeeded in photographing the human eye, he states that he has obtained an impression of the eye of a cat, while the animal was under the influence of chloroform, which condition, however, he hardly thinks necessary, seeing that its impression can be obtained in so short a space of time.

We welcome with much pleasure this ingenious attempt to still further extend the important applications of light painting, which of late have received so many new extensions; we can hardly conceive of any that can be more valuable than this suggestion, for not only are the structures so minute and so delicate, but so varied and so nu-

merous, that it is most difficult even for the fully initiated to clearly define them, so as to make them clear to a bystander. Hence there is little wonder that a non-professional artist who knows not what he is to see, should be puzzled to make them out, and still more so to depict them. Of this, every writer, Mr. Hogg amongst the number, complains, and all find it most difficult and costly, sometimes almost impossible, to obtain truthful representations of those numerous changes in the eye, which the pathologist is so anxious to secure. Should hereafter photography be capable, as we now incline to hope it may be (it has already been most usefully applied in depicting accurately and cheaply external changes and diseases), at no very distant time, of illustrating the hitherto hidden recesses of the human eye, it will supply a desideratum of no ordinary importance; for an absolutely correct picture of the living eye in health and disease will then be within the easy reach of every student of medicine, and thus one great cause of ignorance will be removed. While, therefore, Dr. Roseburgh cannot as yet lay claim to complete success, he deserves credit for the advance which he has made on the road to it.

ELEMENTARY CHEMISTRY.*

Dr. Apjohn, Professor of Chemistry in the University of Dublin, has recently added another to an already numerous class, the Manuals of Chemistry for beginners. It is said that few preachers close their useful careers without, at some time or other, publishing a sermon or volume of sermons. A like result appears to occur under similar circumstances with another class of men. Most of those who have to deliver at stated intervals a course of elementary scientific lectures, in which, owing to the quickly-changing audience, there is not scope for much extension or variety, feel tempted to commit to print their favourite explanations and demonstrations, and not a few yield to the temptation.

As might be expected, the little books developed under these conditions bear a strong resemblance one to another. Dr. Apjohn's manual is a fair specimen of this class, not among the worst, but, we must in honesty add, not among the best.

We prefer, therefore, to offer a few general remarks upon elementary works in chemistry, using that of Dr. Apjohn by way of illustration, rather than to attempt a detailed criticism of a not very characteristic performance. In one respect, however, Dr. Apjohn has departed from the established usage; we mean, in the limitation of his subject-matter. He leaves the vast topic of organic chemistry untouched, excepting that he gives a brief account of a few of the simplest and most commonly occurring combinations of carbon, such as oxalic acid and

* 'Manual of the Metalloids.' By James Apjohn, M.D., F.R.S., M.R.I.A., Professor of Chemistry in the University of Dublin. (One of Galbraith and Haughton's 'Scientific Manuals.') Longmans.

cyanogen. And here he appears to us to follow exactly the right course. But we do not understand why he has preferred to treat only of the metalloids in a work "intended as a handbook in Chemistry for students in Medicine and Engineering." Any group of elements, no doubt, may furnish ample material for a volume addressed to scientific readers; but what a beginner in chemistry needs is a sketch, however slight, of the whole subject; and it seems better that this should be presented to him in a continuous form than in a manual of the metalloids, and, if such a work is to follow, a manual of the metals.

A difficulty attendant upon the first steps taken in any science, is that of remembering or feeling an interest in the facts before acquiring some notion of the general principles under which they have been arranged, and on the other hand, of understanding the general principles without a knowledge of the facts. In chemistry, at any rate, there need be no hesitation as to the alternative a beginner ought to adopt. Dr. Apjohn has followed the usual practice in prefacing his detailed account of particular substances with an introduction, in which he deals with the laws of chemical combination, atomic weights, the classification of the elements, &c. We venture to think this practice inexpedient. Every teacher of chemistry must have had occasion to observe the bewilderment of a beginner, who attempts to read a manual in which this order has been followed. A curious compromise is adopted in the useful volume on chemistry, written by the late Professor Wilson for Chambers's Educational Course. The first fifteen pages are occupied by an excellent account of the method of chemistry, and its relation to other sciences. Then follow fifty pages of theoretical explanations, also good, but to a beginner probably unintelligible. In the preface, the reader is advised to skip these fifty pages, and pass on to the account of oxygen and hydrogen. The plan of first communicating some of the facts of chemistry, and then attempting their explanation, was adopted by Fownes, and is followed also by Dr. Bernays, in his 'First Lines in Chemistry.' We cannot express too strongly our conviction, that in teaching natural science, the historical method should be followed as far as possible. The order of discovery, and of the development of scientific ideas, is obviously not fortuitous, but depends upon a natural connection between one substance, or one mode of thought, and another; and it is in this order that each learner will best advance from facts and ideas which he has already gained to others which to him are new.

One difficult problem which the authors of scientific compendiums have to solve, is that of taking a comprehensive view of a large subject, and using the detail necessary for clearness, within the limits of a manual. They ought therefore to be jealous of admitting to their pages any matter, however useful, which will not directly serve the purpose of conveying to beginners a knowledge of the science. Too often the science lies buried beneath a mass of useful information. The process of purging itself of its applications is, we suppose, one that every science must go through at a certain stage of its development. Each kind of knowledge, before it has become extensive, and before it has imposing generalizations to show, is valued

for its uses and not yet for its own sake. At a later stage, when the science is an object of interest independently of its applications, some account of these is not unnaturally mixed up with its teaching, being introduced partly for the sake of illustration, partly to exhibit its practical importance. For example, the books of arithmetic now in common use, and, we believe, still more those of an earlier date, give "rules" for the performance of various commercial calculations, which it is no doubt well to teach to those who will have occasion to use them, but which should be dissevered from the systematic study of the science of number.

We observe to a much greater degree a similar medley of science and its applications in works on Chemistry. We will borrow from Dr. Apjohn's manual a few examples of the kind of useful information which appears to us out of place in a scientific treatise. Under the head "Phosphorus" (p. 389), we find an account of the manufacture of lucifer matches; under carbonic acid, a discussion on ventilation, and an account of the preparation of aërated drinks (pp. 491–493). No less than three-and-twenty pages are devoted to the manufacture, purification, and illuminating power of coal-gas. The following extract from the chapter on Carbon will serve well to convey our meaning:—

"The diamond is valuable for cutting glass, and its powder is much used for cutting and polishing the diamond itself, and the harder gems. It is, however, principally employed as an ornament for the person; and is worked by the lapidary into forms which have received respectively the names of the *rose* and *brilliant*. The *rose* is flat below, and is cut above so as to exhibit 24 facets. The form of the *brilliant* is the same; but it is domed below as well as above, and is similarly cut on the two surfaces. When cut and polished, a diamond weighing one carat is valued at 8*l*., and its price augments as the square of its weight, until this latter reaches 20 carats; above this weight its price rises in a much quicker ratio."

It may be useful to know these facts, but assuredly they have very little to do with chemistry. Descriptions of the mode of preparing substances on a large scale, and tables for ascertaining the strength of an acid from its specific gravity, might also be excluded; the former, because they illustrate no chemical principle which an experiment on the small scale does not better illustrate; the latter, because though invaluable in a work of reference for laboratory use, they are not adapted to be read through or remembered.

The language of chemistry presents grave difficulties to those who are commencing the study, not only because of its lengthy and often barbarous character, but because of its ambiguity, one substance having frequently a number of names. This want of uniformity appears to be a necessary consequence of the rapid progress of the science. New ideas require new words, and until they have met with general acceptance or rejection, the new and the old words are in use together. All that a writer can attempt is to make as consistent a selection as possible, balancing the claims, often opposed, of scientific accuracy and of usage. Even if usage could be summarily disregarded,

which is least of all possible in a text-book, a selection on scientific grounds is no easy matter. There are, for example, advantages in a name which involves no hypothesis, such as caustic potash, prussic acid, aniline; and there are advantages in a name which suggests to a chemist the generally received formula of the substance, such as hydrate of potassium, hydrocyanic acid, phenylamine. As chemical knowledge advances, bodies of more and more complex constitution, that is, containing in one molecule a greater number of atoms and susceptible of a greater variety of decompositions, are separated out from natural products and investigated, or are built up by the now systematic processes of chemical synthesis. These bodies we represent by formulæ, which indicate the number and kind of atoms composing their molecules, and suggest as far as possible their modes of formation and decomposition. Chemists have striven to make the language of chemistry keep pace with this increase in their knowledge and in the complexity of their formulæ. Probably the attempt must be given up. It is impossible to compress into a name facts which a formula may convey, but which require sentences for their verbal expression. As a consequence of this attempt, chemical names have become sentences, and it is often shorter as well as clearer to write down the formula of a substance than to call it by its name. In the future nomenclature of chemistry we conceive that the formula of a substance will be its name, and that we shall no more expect to have a word corresponding to every formula than to have a name for every algebraic expression. These considerations, however, apply chiefly to organic chemistry. Where the formulæ of substances are simple, the interval is greater, so to say, between one substance and another, and it has not been difficult to apply to each a characteristic name composed of a moderate number of syllables. Almost the only innovation sanctioned by Dr. Apjohn is the use of the names carbonate of sodium, &c., instead of carbonate of soda, &c. It is to be hoped that this change by which the names of salts become uniform and free from theory may soon meet with general adoption. The old terms 'oil of vitriol,' 'muriatic acid,' 'barytes,' 'strontites,' 'barytic water,' 'water of ammonia,' and others, to which Dr. Apjohn adheres, appear to us to have been deservedly superseded. Dr. Apjohn must pardon us for venturing one or two verbal criticisms. The name metaphosphoric acid does not mean 'phosphoric acid associated with something else (water),' p. 396, but changed, or—to illustrate this use of the preposition—metamorphosed, phosphoric acid. 'Hexangular' is a bad substitute for hexagonal, and such expressions as 'per saltum' and 'quam proximè' have no advantage over their English equivalents.

Graver objections attach in our opinion to expressions of another class still much in vogue among chemists. We mean the phrases, for they are nothing more, which represent as the cause of a phenomenon some hypothetical force or law, whose existence is merely an inference—and, as we think, an unmeaning, unscientific inference—from the phenomenon itself. We still recognize under different guises the famous explanation of Molière's physician. "Why," it was asked, "does opium send a man to sleep?" "Because," answered the sage, "it

possesses a soporific virtue." In confirmation of this remark we will make a few extracts from Dr. Apjohn's pages. When describing the process of filling a balloon with dry hydrogen, he says, "The oil of vitriol and potash, in consequence of their great affinity for moisture, dry the gas in its passage to the balloon, and at the same time slightly augment its levity." (p. 135.) That oil of vitriol and potash absorb moisture when exposed to the air, and that heat is developed when they are mixed with water, are facts. We pass beyond our knowledge when we infer from these facts the existence of a cause, resident in these bodies, which we call their *affinity* for water. And when we proceed to speak of this supposed force as accounting for the absorption of moisture or the development of heat, we are simply deluding ourselves with words.

The same remarks will apply, *mutatis mutandis*, to other similar passages. "Sulphur and iron filings, when mixed and moistened with water, have a strong affinity for oxygen. If, therefore, such a mixture be placed in a light capsule floating on water, and that a bell-shaped or cylindric jar be inverted over it, the oxygen of the air is gradually absorbed, and the residual gas is nitrogen." (p. 170.)

And again, with reference to the supposed isolation of fluorine by the action of chlorine gas on fluoride of silver, Dr. Apjohn says:—

"Such an experiment could not be made with any prospect of success in glass or even in a platinum vessel; for though the fluorine was set free, such is the energy of its affinities that it would at once enter into combination by acting on the materials of which the apparatus was composed." (p. 378.)

If we may put confidence in Kämmerer's results, "the energy of its affinities" does not produce this effect. A single line will furnish us with one more example: "Phosphorus is a very inflammable substance, the result of its strong affinity for oxygen." (p. 388.)

We will quote, lastly, from Dr. Apjohn's introduction, his general account of the theory of chemical affinity. It is a clear statement of the common doctrine on the subject.

"We come now to the consideration of affinity, the force in virtue of which two or more simple atoms combine so as to form a compound atom. It is to the chemist the most important of the forces active in nature; for to it he refers the numberless combinations and decompositions of which bodies are susceptible."

Now, there is no point, in our opinion, which it is more important to set plainly before a student, than the fact that, as to the cause of chemical change—the forces, if there be forces, which move the atoms, if there be atoms—we know nothing at all. Science has to do with motion, with changes, with relations, but not with force. Probably, if the term "affinity" could be got rid of altogether, it would be a gain to chemistry; but at least it should be used only, as "vital force" is still sometimes used, under protest, as a name for the unknown cause or causes of chemical action.

But it is not only in the philosophy of chemistry that this negligence in distinguishing between fact and hypothesis is observable. In

giving a systematic account of the combinations of the elements, it might be thought an important part of the duties of the writer to discriminate clearly between those substances that have been separated and analyzed, those whose existence is rendered probable either by experimental evidence, falling short of demonstration, or by considerations of analogy, and those in favour of whose existence there is no presumption whatever. The reader of most elementary works on chemistry will look in vain for this distinction. He is presented with the names and formulæ of a host of imaginary substances, many of which are so entirely without analogues that no chemist would dream of attempting their preparation. Dr. Apjohn gives three lists, and similar lists may be found in most chemical text-books, of the oxides of Sulphur, Phosphorus, and Carbon. The first list consists of seven oxides, the second of four, the third of six. Chemists are actually acquainted with two oxides of Sulphur, two, or perhaps three, oxides of Phosphorus, and two oxides of Carbon. Of the remaining oxides it is said that they "exist only in combination." This is one of those treacherous phrases of which chemistry were well rid. In this sense all bodies exist whose formulæ can be made by combining the symbols which compose the formula of an actually existing body. For example, the well-known salt hyposulphite of sodium has the constitution expressed, on the old notation, by the formula $Na\ S^2O^3$. Hence, on this principle, we may infer the existence of substances having the following formulæ:—$Na\ S$, $Na\ S^2$, $Na\ O$, $Na\ O^2$, $Na\ O^3$, SO, SO_2, SO^3, S^2O, S^2O^2, S^2O^3, $Na\ SO$, $Na\ SO_2$, $Na\ SO_3$, $Na\ S^2O$, $Na\ S^2O^2$; of these substances those whose formulæ are printed in italics "exist only in combination." The reason why the formula of one of these imaginary bodies figures as that of "a known oxide of sulphur" (p. 256), is the traditional acceptance of the dualistic hypothesis, according to which every salt containing oxygen consists of a metallic oxide and an acid anhydride. Now we are far from saying that this oxide of sulphur may not hereafter be made, or that there is no argument from analogy in support of this anticipation. Only the same may be said of nearly every one of the hypothetical bodies whose formulæ we have written down. The discovery of the teroxide of sodium, of the protoxide and suboxide of sulphur, of the sodium salts intermediate between the sulphide and sulphite, appears at least as probable. These indications of what we may hope to realize, drawn from the analogy of existing compounds, are the clue which must guide the chemical investigator; but to set before a beginner the names and formulæ of certain substances selected on a particular hypothesis,—one out of many that have been formed,—from among hundreds of others, equally possible, equally unknown, is a course in the highest degree arbitrary and misleading.

We wish to repeat, in conclusion, that our object has been to call attention to various points in which, as we venture to think, the traditional teaching of chemistry is in fault. We have thus been led to notice chiefly those parts of Dr. Apjohn's manual which illustrate the objections we have advanced, and have left without comment, as beside our purpose, the large amount of well-arranged information which it

contains. But while we readily share the modest hope which Dr. Apjohn expresses, that his manual will materially assist his chemical pupils in the University of Dublin, we must express our opinion that a text-book of chemistry, such as we would desire to see in the hands of every beginner, has yet to be written.

BOTANIST'S GUIDES.*

Dr. Dickie having been for some years resident in Belfast as Professor of Botany and Natural History in Queen's College, has examined the Flora of the northern part of Ireland, and the result is given in the first-named publication now before us.

Like all the works of the same author, it displays accurate observation combined with a thorough knowledge of species. The district embraced in the 'Flora' lies to the north of the fifty-fourth parallel of latitude, and extends due west from Dundalk. It includes the whole of Ulster (except the most southern portions of Monaghan and Cavan), and the northern portions of Leitrim, Sligo, and Mayo, belonging to Connaught. As to the general geological features of the district, it is stated that Silurian formations occur in the South-east, Metamorphic and Granitic rocks in the North and North-west, Carboniferous Limestone in the South-west, and Devonian rocks in part of the interior. In the East there is an extensive mass of basalt and chalk; greensand and oolite are here and there exposed. The extreme highest points are;—in county Down, Sleeve Donard, 2,796 feet; in Donegal, Muckish and Engal, respectively, 2,190 and 2,400 feet; in Mayo, Nephin, 2,646 feet. Surrounded as Ireland is by the Atlantic, and its northern parts so indented that arms of the ocean extend considerably inland, as might be inferred, the climate of even the most northern parts is comparatively mild and moist. The extreme ranges of temperature are moderate when contrasted with those recorded in different parts of Great Britain. The character of the 'Flora' indicates this. In marine plants the occurrence of many southern species in the sea of the North of Ireland points out the influence of the Gulf Stream in a marked manner.

Taking Mr. W. C. Watson's divisions, Dr. Dickie gives the following statements as to the Ulster Flora:—

1. British.—The number of plants belonging to this division, as given in the Guide, are—Dicotyledons, 347; Monocotyledons, 136. Several of these are not so abundant as usual, such as *Draba verna*, *Cardamine amara*, *Arabis hirsuta*, *Adoxa Moschatellina*, *Origanum vulgare*, *Myosotis collina*, *Mercurialis perennis*, *Milium effusum*, *Carex fulva*.

2. English.—The total number of this type in the British Flora is about 396; of these there are, in this district, 141 Dicotyledons and 36 Monocotyledons, giving a total of 177.

* 'A Flora of Ulster, and Botanist's Guide to the North of Ireland.' By G. Dickie, A.M., M.D., F.L.S., Professor of Botany in the University of Aberdeen. Belfast: C. Aitchison; London: Lovell Reeve. 18mo, pp. 176.

3. Scottish.—The total number in Britain may be estimated at about 69; those in the Ulster list are 34 Dicotyledons and 19 Monocotyledons; total 44.

4. Highland.—Species of this type are estimated at 100; in the North of Ireland the number is 29, of which 26 are Dicotyledons.

5. Atlantic.—The total number in Britain is about 60; of these there are in the list 23, of which 20 are Dicotyledons.

6. Germanic.—The representatives of this type are 190, and only 3 are in the list, of which 2 are Monocotyledons.

7. Local.—Under this head are included 2 species not found in Britain—*Arenaria ciliata* and *Carex canescens*, and one, *Calamagrostis stricta*, extremely local in Britain.

The plants which occur on the summits of the higher mountains are as follows:—*Arbutus Uva-Ursi*, *Calluna*, *Empetrum*, *Galium saxatile*, *Salix herbacea*, *Vaccinium Myrtillus*, *Carex pilulifera*, *C. rigida*, *Festuca ovina*, and *var. vivipara*, *Luzula sylvatica*, *Juncus squarrosus*, *Poa pratensis*, *Armeria vulgaris*, *Campanula rotundifolia*, *Euphrasia officinalis*, *Potentilla Tormentilla*, *Rumex acetosa*, *Agrostis vulgaris*, *Aira flexuosa*, *Lycopodium Selago*, *Saxifraga umbrosa*.

The author includes in the 'Flora' the Phanerogamous plants along with Ferns and their allies. A list of the species is given, with full reference to their localities, a notice of their period of flowering, their range, and the type to which they belong. A supplement is given containing a list of the species which are either not strictly indigenous, or regarding whose occurrence in the district there is some doubt. We have no hesitation in recommending the work as one of great value to the botanist who wishes to explore the Flora of the North of Ireland.

The counties embraced in Dr. Dickie's 'Botanist's Guide'* to Aberdeen, &c., are very interesting in a botanical point of view. They exhibit a Flora ranging from the sea-shore to the height of 4,295 feet. The author gives a general view of the physical character of the counties, and notices specially their meteorology. The geology of the counties is also given, from the pen of Mr. Cruickshank. The British Dicotyledenous orders not represented in the Flora are Berberidaceæ, Frankeniaceæ, Tiliaceæ, Aceraceæ, Balsaminaceæ, Celastraceæ, Rhamnaceæ, Tamariscaceæ, Cucurbitaceæ, Loranthaceæ, Jasminaceæ, Orobanchaceæ, Amarantaceæ, Elæagnaceæ, Thymelæaceaæ, Santalaceæ, and Asaraceæ. The Monocotyledonous orders not represented are Amaryllidaceæ, Tamaceæ, Hydrocharidaceæ, and Restiaceæ.

Taking Mr. H. C. Watson's Floral types, the following report by the author gives an idea of the characteristic features of the Aberdeenshire Flora:—

1. British.—Most of these constitute our common plants, almost everywhere diffused, and many of them familiar to all as ordinary weeds. Some of this type, however, though abundant in more southern

* 'Botanist's Guide to the Counties of Aberdeen, Banff, and Kincardine.' By G. Dickie, A.M., M.D., Professor of Botany in the University of Aberdeen. 18mo, pp. 344. Aberdeen: A. Brown & Co.; London: Longman & Co. 1860.

parts of Britain, become scarce here, and may be reckoned among our rare species; such as Ranunculus auricomus, Arabis hirsuta, Arenaria trinervis, Bidens cernua, Lycopus Europæus, Listera ovata, Malaxis paludosa, Alisma ranunculoides, &c.

2. ENGLISH.—Of this type comparatively few reach Aberdeenshire, and some of them, though now extensively spread, very probably may have been introduced along with seeds of agricultural plants.

3. SCOTTISH.—Plants of this division are well represented in this part of Scotland, being 58 in number, and, therefore, about $\frac{5}{6}$ of the British species, so designated, occur here. Most of them are abundant, and several are species highly prized by Southern collectors. A few examples may be mentioned:—Rubus saxatilis, Trientalis Europæa, Linnæa borealis, Pyrola media, Pyrola minor, Goodyera repens, and Listera cordata. Three of these, Linnæa, Trientalis, and Goodyera, may be specially noted as very widely distributed and abundant here.

4. GERMANIC.—There are only 8 examples of this type on our list, and they are mostly rare or local plants; the total number of such in the British Flora being estimated at more than 190.

5. ATLANTIC.—Sedum anglicum and Scilla verna are the only representatives; the latter confined to the North-western part of the coast, on the borders of the Moray Firth.

6. HIGHLAND.—The plants belonging to this division are estimated at about 100 species in the whole British Flora; of these $\frac{8}{10}$ are found in the list. Many of these are very local, and entirely confined to the higher districts. A few of these reach the coast, and are found almost at the sea-level, *viz.* Sedum Rhodiola, Saxifraga oppositifolia, S. hypnoides, and Polygonum viviparum. Some others appear at a lower altitude along the course of the Dee and Deveron. Such have, probably, been transported by floods, *viz.* Oxyria reniformis, Epilobium alpinum, and Alchemilla alpina. Among the more interesting of this type found in the interior, and usually very local, may be mentioned Astragalus alpinus, Mulgedium alpinum, Arbutus alpina, and various species of Saxifraga, Hieracium, Salix, Juncus, Carex, and Poa.

As regards altitudinal distribution, the following remarks are made:—The upper limit of Pteris aquilina is considered as marking the upper limit of the Super-agrarian Zone, and therefore also that of cultivation in Britain. The limit of this fern varies here from 1,600 to 1,900 feet: very rarely, however, does it attain the latter. In several localities, on the bare stony sides of the hills, the limit is found to be 1,600 to 1,700 feet. At various places, even more than forty miles from the sea, cultivation at high altitudes is frequent. In some of the inland or higher parts of the Super-agrarian Zone, several plants of the Highland type constitute a permanent feature of the vegetation, such as Cerastium alpinum, Asplenium viride, Polygonum viviparum, and Arabis petræa.

The Zones of Watson's Arctic region are well represented in Aberdeenshire. The Mid-Arctic Zone is peculiarly rich in rare forms of the Highland type, such as Astragalus alpinus, Carex rupestris, C. leporina, C. Vahlii, Erigeron alpinus, &c. At the extreme part of

the Super-Arctic Zone, the Highland forms alone occur. Thus, on the summit of Ben Maedui, only seven flowering plants are found, *viz.* Silene acaulis, Saxifraga stellaris, Salix herbacea, Luzula spicata, L. arcuata, Carex rigida, and Festuca vivipara. Along with them are associated Lycopodium Selago, and several other Cryptogamic plants.

A complete list is given in the work of all the Phanerogamic and Cryptogamic plants of the counties, and full references to their localities. There is also a map of the district, with a delineation of the various zones of vegetation, and a notice of the plants which mark different altitudes. The 'Guide' is compiled with great care and correctness by one who is thoroughly conversant with the Flora, and who has for many years been in the habit of visiting the localities. Dr. Dickie has done good service to practical botany by this publication, which ought to be the pocket companion of every one who means to explore the floral treasures of the North of Scotland.

BRITISH AND AMERICAN CONCHOLOGY.*

Whatever may be the future destiny of those constituent groups which collectively form the genera of natural science, it is certain, that from the time of Linnæus they have, in numberless instances, endured a considerable amount of severe cross-examination, and have stood their ground with much firmness. Species are indeed, at present, somewhat stubborn facts, and exhibit not a few very remarkable idiosyncrasies, which have to be disposed of before the theory of development can be regarded as perfectly established.

To an unprofessional observer, the aspect of a named collection, in almost any branch of natural history, is very perplexing. In entomology, for instance, he may notice a series of insects, under the same specific name, yet differing from each other in size, colour, and even in form; whilst not far from these, two groups may appear, in one of which the specimens are so like those of the other, as to be apparently indistinguishable, yet he may find the groups marked by different specific, perhaps even by different generic, names. The arrangement may, nevertheless, be perfectly accurate and easily intelligible to the entomologist, who, in a variable species, at once recognizes the specific identity of insects, differing at first sight, as much as a magpie does from a jay; whilst between two constant species, he knows the characteristic difference is very slight. We may be more or less inclined to attach importance to specific dis-

* 'British Conchology; or, an Account of the Mollusca which now inhabit the British Isles and the surrounding Seas.' Vol. II., 'Marine Shells: comprising the Brachiopoda and Conchifera, from the Family of Anomiidæ to that of Mactridæ.' By John Gwyn Jeffreys, F.R.S., F.G.S., &c. Van Voorst.

'Observations on the Genus Unio: together with Descriptions of New Species, their Soft Parts and Embryonic Forms in the Family Unionidæ.' By Isaac Lea, LL.D., President of the Academy of Natural Sciences of Philadelphia, &c. With ten plates. Philadelphia: Printed for the author.

tinctions, but at all events, it must be evident that discrimination between species is a matter of empiricism, and can only be accomplished by a naturalist who has a thorough practical acquaintance with all the constituents of a genus in their various relations towards each other, and under all the circumstances of the life-history of each species.

Dr. Lea has devoted a large share of his life to the attainment of a thorough acquaintance with the single conchological family Unionidæ. The Unios are not general favourites with shell collectors, perhaps because there is, to say the least, a strong family resemblance between all the species, and a good series requires the whole of a very capacious cabinet for its reception. Nevertheless, these fresh-water mussels have had a few enthusiastic admirers and collectors, from and before the time of Featherstone, whose book of travels in North America gives an amusing account of perils and hardships undergone in pursuit of Unios. The tenth volume of Dr. Lea's work on the Unionidæ contains a very valuable description of the soft parts and embryonic forms of many species, the shells alone of which had been previously described. It is a pity that the work is so strictly confined to technicalities. Books of natural science will never gain their due respect from mankind till they openly recognize the fact that an accurate description of the habits and dispositions—in short, the biography of a living thing—is just as purely and as truly scientific as the most elaborate treatise on its physiology.

The North American Unionidæ include, according to Dr. Lea, more than seven hundred species, whilst the rivers in Europe do not produce more than a dozen.

The second volume of British Conchology, by Mr. Jeffrey's, exhibits equally with the first, on the part of the author, a profuse expenditure of time and energy ungrudgingly bestowed on his favourite pursuit.

In reading the book, it is easy to fancy oneself inhaling the fresh odour of the sea-shore, or of the sea-bottom; turning a stone for a chiton, or poring over the dripping contents of a dredge in search of rissoæ; on the whole, however, the proportion of matter unattainable from other sources seems to be somewhat less in this than it was in the former volume. Many readers will, no doubt, think that the author has acted judiciously in abstaining from drawing inferences from his vast store of facts, either in favour of, or in opposition to, the theory of natural selection; yet it is daily becoming more difficult to awaken any interest in matters which were the subjects of warm discussion only a few years ago. Even the discovery of a new species is less cared for: we want to know more of the old ones; for if Mr. Darwin's theory be the correct one, there is not an animal or a plant of any species—far more than this, there is not a single character belonging to an animal or a plant of any species, but it has its own wondrous ancestral history to yield as a reward for patient study. On the other hand, if we regard "natural selection" as a mere conjecture, *every part of every living* thing may be examined as a witness to the probability or the improbability of the grounds on which the conjecture has been made. All must admit that Mr. Darwin has fairly challenged

refutation; he has propounded no misty, indefinite, unintelligible theory; he has made two assertions that anybody may understand—1st. That species have arisen by divergence in descent from a common stock; 2nd. That the direction of the divergence has been determined on utilitarian principles. It is inconceivable that such a theory can long remain undecided. It is a reproach to science, that the materials for its support or refutation are not at hand in overwhelming plenitude. From a Rhizopod to an elephant, from a particle of red snow to a Wellingtonia, every organism invites the inquirer after truth to come and hear what it has to say upon the question. The fact is, that naturalists have been too much occupied with systems of classification, and with establishing their various personal claims to scientific honours; and now the work that might have been done long ago, remains to be done; for Mr. Darwin himself would be the last man in the world to assert that he had arrived at anything like a demonstration. He has, however, succeeded in giving the great problem a most unexampled prominence; the rising generation will probably possess its satisfactory solution.

PAMPHLETS.

The Colossal Bird of Madagascar.*

In the year 1850, a French ship-captain, named Abadie, being on the south-east coast of Madagascar, observed in the hands of a native the shell of a gigantic egg, which had been perforated at one of its extremities and employed for domestic purposes. M. Abadie being attracted by the unusual dimensions of the egg, set to work to procure specimens of it, and ultimately succeeded in obtaining from the natives, besides the example first seen, two others. One of these was found in the *débris* of a recent land-slip, the other was disinterred from a recent alluvial formation, together with some bones of apparently no less gigantic size.—Upon these objects, which were shortly afterwards forwarded to Paris, the late Professor Isidore Geoffroi St. Hilaire founded a new genus and species of extinct Struthious birds, allied to *Dinornis*, for which he proposed the name, *Æpyornis maximus*.† The most striking character of the eggs of *Æpyornis* is their enormous size. The largest of the two received at Paris measured in circumference lengthwise no less than 2 feet 10 inches, and breadthwise 2 feet 4 inches. Its extreme length in a straight line was about 12 inches. Professor Geoffroi St. Hilaire estimated that it would contain 10⅛ quarts, or nearly as much as six ostrich-eggs. A large ostrich egg, we may mention, measures only about 6¼ inches in length, being little more than half that of the *Æpyornis*. But it would be very hazardous,

* 'A Paper upon the Egg of Æpyornis Maximus, the Colossal Bird of Madagascar.' By George Dawson Rowley, M.A.

† Compt. Rend. de l'Ac. Sc., 1851, Jan. 27.

as Professor Owen has remarked, when making observations on these eggs before the Zoological Society,* to conclude hence that the size of the bird was in proportion to the great dimensions of its eggs. The little *Apteryx*, or kiwi of New Zealand, produces an egg $4\frac{3}{4}$ inches in length, and, when freshly laid, "nearly equal to one-fourth of the weight of the living bird."† In fact, Professor Owen considers that the "*Æpyornis* did not surpass in height or size the *Dinornis giganteus*, and that it was probably a somewhat smaller bird."

The eggs of the *Æpyornis* are now well known to scientific men, from casts which have been prepared to imitate the originals in the French collection, and liberally distributed amongst all the principal Museums of Europe and America. But, as regards originals, the Parisian examples have remained, as far as we know, unique, until the arrival of the example described in the present pamphlet, which was first exhibited in the International Exhibition of 1862. It was obtained, Mr. Rowley informs us, at Mananzari, on the east coast of Madagascar, at a depth of 5 feet in a hill of ferruginous clay, by some Malgaches digging for iron ore. Mr. Rowley tells us that this specimen, which he obtained by purchase from a M. Brunet—the secretary of a French charitable association — slightly exceeds the two Parisian eggs in dimensions, and is, therefore, the largest known example of the eggs of *Æpyornis*. Without grudging Mr. Rowley the acquisition of such an addition to his collection of eggs, for which, we believe, he paid a handsome price, we cannot help expressing our regret that the authorities of the British Museum, to whom we know the offer was made, did not secure such a prize for our national collection.

Spectrum Analysis.‡

We may commend this little book to our readers as an excellent practical guide to the use of the Spectroscope, which all who are beginning to experiment with the instrument will do well to study. Whether its revelations, so far as the materials of our own globe are concerned, are come to an end or not, it will always be looked upon as an important means of research, with the use of which every chemist will do well to make himself acquainted. Although the application to qualitative analysis seems limited and somewhat delusive, there are some who anticipate the day when further researches may show that the spectroscope will be available not only to discover the presence of different substances, but also to show their several proportions. In these hopes we hardly share, but we are glad to lend any aid to extend the use of the instrument.

One objection often brought against the usefulness of the spectro-

* *See* P. Z. S., 1852, p. 9.

† *See* Sclater, in P. Z. S., 1859, p. 350.

‡ 'Instruction Pratique sur l'Analyse Spectrale, comprenant: 1. La Description des Appareils; 2. Leur Application aux Recherches Chimiques; 3. Leur Application aux Observations Physiques; 4. La Projection des Spectres.' Par M. Louis Grandeau. Paris: Mallet-Bachelier.

scope is its excessive delicacy. It is hard, sometimes, to tell whether the spectrum seen is given by the material under examination, or whether it is not caused by minute portions of the substances floating in the atmosphere. It is for this reason that M. Grandeau insists strongly upon the necessity for a separate and distinct laboratory in which to carry on spectrum investigations. This laboratory, he adds, should be provided with the means of effecting a thorough ventilation, so as to get completely rid of volatilized matter.

The author also points out the advantage of securing a room with a southern aspect, the window of which can be darkened with wooden shutters, a circular hole in one of which may admit a beam of solar light for examination and comparison.

No less useful to chemists beyond the reach of gas, is the hint that in the absence of a Bunsen's jet the best source of heat and light to employ is a lamp fed with wood spirit. It is also very properly pointed out that when either such a lamp or a common spirit lamp is employed, the brass collar through which the wick passes should be well platinized to prevent the appearance of the spectrum of copper, some of which metal is always carried along by the spirit.

The spectrum of copper is rather complicated, but it may mislead a young experimenter, who would, however, be able to set himself right, if he checked his results with the spectroscope by an ordinary chemical analysis. And here we may mention what M. Grandeau calls a most happy coincidence. It is the circumstance that those substances which are most difficult to detect by purely chemical means, are just those which give the most simple and characteristic spectra. Take as an illustration the fact mentioned in our Chemical Chronicle. Plattner had a large amount of cæsium in his hands, and yet failed by chemical means to discover that it was anything different from potassium. Bunsen had a very minute proportion, but instantly recognized in the two blue lines the sign of something new. How minute a proportion of some metals may be discovered is stated by the author, and we quote his statement without, however, guaranteeing the accuracy of the determination. He says, that the observation of the lines of the spectrum enables us to prove most distinctly the presence of 0·000,000,3 of a milligramme of sodium, and 0·000,000,9 of a milligramme of lithium!

The exact value of the spectroscope in analysis is, as we have hinted, yet to be determined, but the value of the results already arrived at by its means are unquestioned. Four new simple bodies have been brought to our knowledge in the same number of years, a result unprecedented since the time of Davy; and although a chemist can hardly wish the number of simple bodies to go on extending at this rate, we hope there is yet a rich harvest to be reaped to reward the labours of other observers.

We have already expressed a warm commendation of this book, which we have only to add extends to every part but the chromolithographs at the end. If anyone should arrange for its translation into English, he had better get fresh plates executed.

NOTES AND CORRESPONDENCE.

Recent Contributions to Natural History and Ethnology in France.—1. Pasteur on Ferments; 2. Tremaux on the White and Black Races in Africa; 3. Lartet and Christy on Pre-historic Human Remains. By Th. Lacaze Duthiers (Professeur à l'Ecole normale sup. de Paris).

At the time when Lamarck wrote, it was still possible to believe in spontaneous generation; and, indeed, it was easy to justify such a theory by a reference to facts then unexplained, and otherwise inexplicable. But since then, further light has been thrown upon a whole series of living forms, whose origin and development had before been regarded as insoluble problems. The advocates of the theory of generation without parents, or "heterogenesis," as it is termed, rapidly decreased in number, owing to the difficulty they found in sustaining their opinions, and a period seemed to have arrived when such inquiries had attained a degree of precision which excluded the possibility of a revival of this old world controversy.

Nevertheless, M. Pouchet, of Rouen, doubtless unconvinced by the most recent discoveries which had thrown such light upon the mystery of generation amongst the lower animals, some years since presented to the Academy of Sciences a number of detailed facts which, he believed, demonstrated satisfactorily the production of microscopic organisms without parents. This communication led to a controversy, and the Academy of Sciences adopted the question as the subject for one of its prizes, and finally awarded the distinction to an eminent chemist, M. Pasteur, whose labours clearly exhibited the errors into which M. Pouchet had fallen. Still the naturalist of Rouen does not acknowledge himself vanquished. Far from this, he is incessantly attacking M. Pasteur; with him have allied themselves MM. Jolly and Musset, naturalists holding similar views, and the combination of these three observers necessarily gives weight to the opposition raised against the decision of the committee which had already judged the whole question.

In the interests of science, and for the dignity of the Academy of which he is now a member, M. Pasteur has requested that a commission should be appointed with a view of witnessing a series of comparative experiments to be instituted by his adversaries and himself, and the decision of the judges should finally dispose of the controversy. The challenge was frankly and distinctly given; it was accepted in the same spirit by his opponents; and each party was to repeat its experiments before the committee in confirmation of its views.

The time arrived, when MM. Pouchet, Jolly, and Musset requested an adjournment, fearing that the changes of temperature in the spring might cause the failure of their so-called physiological experiments. The delay has been granted, and the commission will not meet until the 19th of June of the present year. As we may well imagine, M. Pasteur has not failed to draw attention to the fact that he was ready at any time, and at the call of the Academy, for with a stove

any requisite temperature may at all times be obtained for any kind of experiments.

We trust that there may be no further delay, for it is necessary indeed that a solution, free from any kind of suspicion, should be arrived at, in order to close a debate already too long protracted.

The experiments of M. Pasteur are possessed of singular clearness, precision, and interest, and are conducted on the broadest general basis. He is not content to take at hazard a few special results; but he studies the more extended phenomena of putrefaction, fermentation, and disorganization of organized beings. Wherever he observes the decomposition of an organic compound he also encounters myriads of forms, be they animal or vegetable, which accomplish this decomposition. He seeks the conditions necessary for their existence, in order to deduce from these the laws of their development and reproduction, and in the major portion of the phenomena attributed to slow oxidation, such as fermentation and putrefaction, he sees only the manifestations of the vital force exerting itself in the world of infinitely minute beings.

"*Life*," he says, "*presides everywhere over the work of death*," a remarkable expression, which exhibits strikingly the practical and philosophical mind of the great academician. As a naturalist I heartily approve this statement, emanating from a chemist, for it is, to me, an indication of a return to the study of true biological science —a science far too much neglected, and one, the importance of which is often misapprehended, and its action too much restricted.

When, owing to the new line of inquiry here indicated, the results due to vital force, or, if the phrase be preferred, due to the action of the organized world upon itself, are fully recognized; results of the most striking character which are often attributed to the *chemical* or *physical* forces in the explanations of the phenomena of daily life, then it will be seen that the return of the primitive elements to the inorganic world is but the manifestation, the most striking, though apparently the humblest, of the endowments of animal and plant life. It would be impossible to refer here to all the varied observations of M. Pasteur on this subject; all we can do is to direct attention to his latest communications, which are of a specially practical character, and it is pleasing to see science descend from the lofty heights of theory in order to guide the researches of the experimentalist, so often conducted in the dark.

Everyone is aware that the "must," or sweet juice of the grape, is converted into wine by the process of fermentation, but this being accomplished, whence does wine obtain its exquisite properties? how does it acquire age?

That the oxygen of the atmosphere was indispensable for fermentation was proved by Gay-Lussac; but M. Pasteur teaches us that, when the fermentation is ended, its part in the process becomes changed. It is absorbed, and, combining with some of the elements of the wine, modifies its flavour and imparts to it its characteristic bouquet.

This explains why wine acquires age more quickly and more readily in porous wooden vessels, where the conditions of absorption are favourable, than in glass vessels; in casks rather than in bottles; in a state of motion rather than when at rest. More attention should therefore be devoted than is usually the case to the aeration, not only of cellars, but also of wine contained in casks.

The must is changed into wine by the action of a lowly-organized plant* which, while developing and multiplying itself infinitely, acts upon the sugar and separates its elements.

When the alcohol resulting from this process is produced, absorption

* Mycoderma Vini.

of oxygen commences; the wine loses some of its qualities and acquires new ones. In a word, it acquires age. But this absorption may be hindered or interrupted by the production of many kinds of vegetables; true parasitic growths, which act like ferments, and so form, by their own peculiar influence, those wines which are commonly named in France sour or acid wines, sweet, bitter, turned, and dry wines.

M. Pasteur, without any hasty attempt at imposing new names on each of these vegetable forms (and in this respect how few botanists would have imitated him), regards them, nevertheless, as so many distinct species, which, by their special action, cause the disagreeable characters of which we have just spoken; and he adopts this practical application well worthy of attention.

The disagreeable flavour of acid wines, of those which are sweet, bitter, changed, &c., cannot be recognized by taste until the change is far advanced, and it is no longer possible to apply a remedy to the mischief; while by microscopic examination the destructive cryptogam may be discovered as soon as it is fairly developed, and its increase may then be checked. A wine may thus be out of condition for a long time before its state is really suspected, and microscopic examination alone can ensure the detection of this state, or watch over its progress.

Doubtless it will be long before full use is made of these scientific data, as well as of the microscope; but we shall not be the less indebted to M. Pasteur for having entertained the happy idea of applying his researches, first undertaken from high and purely theoretical views, to the benefit of a branch of industry so widespread as that of the manufacture and preservation of wines.

Although the variability in a species is considered by some naturalists to be unlimited in extent, yet in the case of man the races to which it has given rise are, some of them at least, so characterized and fixed as to have been regarded by certain ethnologists as distinct species. Now, however, the impression exists, and in this there is very general agreement, that only one single species should be admitted for the human race. But this very intricate and difficult question still remains to be solved: Do the different human races spring from one and the same stock very widely modified, or were they distinct at their origination?

The perplexity we experience in giving a satisfactory answer to this query must cause us to welcome with the most lively interest all observations which are able to throw any light upon it; and in this view we shall here refer to the researches that M. Tremaux has just laid before the Academy of Sciences, for the purpose of showing that in spite of the most distinctive characteristics which appear to divide these races, they may still merge one into another. M. Tremaux was induced, by a concurrence of private events, to undertake a long expedition towards the source of the Nile, and whilst there he was led to make some observations, the results of which, if they are confirmed by subsequent inquiry, will become of very material value. He has remarked that the physical characteristics of the white races are changed into those of the black to the south of the mountains of Upper Egypt, and that on the other hand the black races become white towards the north. In delineating upon a map the position of the peoples of the Soudan, he has drawn tortuous lines, representing promontories, gulfs, and islands, as the limits of the various tribes, and corresponding to the variations in the tribes; and he has found that this map, originally intended only to give an idea of the ethnography, has proved in reality to be the geological map of these countries.

This result, very curious in itself, led him on very naturally to inquire whether some relation might not exist between the nature of the soil and the physical forms of the inhabitants. M. Tremaux has not failed to prosecute this line of research, and by comparing the facts gleaned from science concerning the geology of different points of the globe, with the well-known characters of the people there resident, he has been led to the conclusion that remarkable coincidences exist between the geological formations and the human types. The man who differs most widely from our present white type, lives on the soils of oldest formation, whilst he whom we may regard as the most perfect, belongs to those countries which in the smallest space exhibit the greatest variety of soils, and appertaining to the most modern deposits. The observations of M. Tremaux cannot easily be verified; for long, costly, painful, and even dangerous journeys would be imperative; but the attention of those travellers, who are also naturalists, may well be directed to the opinions which he advances. For they have this especial peculiarity (one rarely to be met with in science) that they are not the result of preconceived ideas, and that the author has only been induced to give them to the world, because, so to speak, he was compelled to yield to the evidence of facts which presented themselves before him whilst engaged in a totally different pursuit.

His conclusions tend to show what influence the dwelling upon certain soils, or in certain localities, would have upon the physical characteristics of man; an influence, which, if fully demonstrated, would explain how the white man has become so modified as to produce the type from which he most widely differs, the Negro — namely, by coming to inhabit those countries where the soil has been formed from the earliest deposits: and how the Negro, on his side, has been able to reach the white type, *viz.* by emigrating to countries formed from soils varied in character, and of recent origin. We repeat, it is necessary to confirm these conclusions, and it would be as imprudent to accept them without reserve as it would be to reject them without due investigation. The inquiry is full of interest, not only so far as the philosophy of science is concerned (for it is intimately linked with the question of mutability of species), but also in connection with the progress of the natural history of man, with which we are now so actively employed.

Naturalists will certainly not have forgotten the sensation which was created last year by the presentation to the Academy of Sciences by M. de Quatrefages of a human jawbone found in the quaternary deposit of the Somme by M. Boucher de Perthes. Incredulity, disdain, and irony greeted the new discovery of the learned and now celebrated archæologist of Abbeville, as, indeed, it had been the case with his earlier announcements.

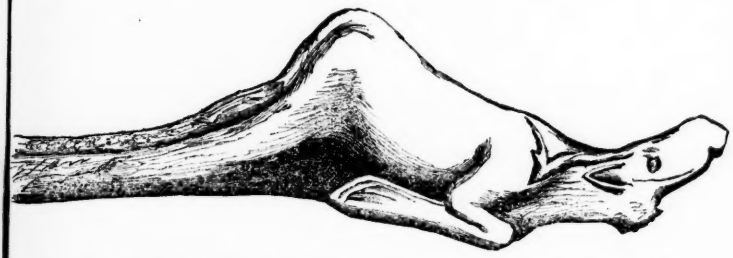
Very shortly afterwards a sort of scientific congress met at Moulin Quignon, to decide whether the famous jawbone found in this locality were really authentic and contemporary with the deposits where traces of human industry had been recognized side by side with huge fossil mammalia. How the conditions are now changed! how far we are removed from that! To-day every one is convinced; and all listen eagerly to any new communication relating to the drift which attests the antiquity of man. Such evidences it is, indeed, easy to find in a country which, like France, is rich in the indications of the very remote existence of an aboriginal race.

The traveller who departing from Paris for the plains of the Garonne, follows the line of the central railway of France, cannot fail to be struck in the neighbourhood of

Périgueux with the appearance of a bed of gravel intermixed with flint, which reminds him of the diluvium of St. Acheul, near Amiens; and after passing further southward, and having reached the valleys of the Beune and of the Vezère, especially towards the station of Eyzies, he must notice, even in the hasty railway journey, the excavations into which the steep rocks, which border on the course of the river, are hollowed out. This part of the centre of France had been until lately very imperfectly explored, but MM. Lartet and Christy, both well known as geologists, have jointly examined the grottos of Périgord. They have collected some objects of extremely high scientific value, which certainly throw a very clear light upon the history of primitive man.* Amongst a mass of flints formed into hatchets, knife-blades, arrow-heads, of bones worked into the shape of needles, of barbed arrows, of harpoons, of amulets or ornaments, and of daggers; and evidencing the existence, among a primitive people as yet ignorant of the use of metals, of a certain kind of industry, and even of art; these gentlemen have been so fortunate as to discover some daggers,† the

Fig. 1.

Fig. 2.



handles of which, although roughly carved and sculptured (Figs. 1 and 2), allow us to recognize without the possibility of a doubt that the engraver has wished to represent the reindeer then living before his eyes. Thus not only the material of which the weapon is formed, but also the designs which ornament it, bear witness to the presence of this animal in the middle of France in pre-historic times.

A piece of carving upon an arrow, unfortunately mutilated in its most important part, the head, gives the impression that the Aurochs (bos urus) was also existing in this same country. For the height of the line of the back above the shoulders

* The observations of these gentlemen, at first presented to the Academy of Sciences (part 58) in 1864, have been published in the 'Revue Archéologique,' 1864.

† These drawings are copied from the "Memoir of MM. Lartet and Christy," in the 'Revue Archéologique.'

in this drawing can only refer to that animal (Fig. 3). Lastly, one other relic presented to the Academy of Sciences is a lumbar vertebra of a

Fig 3.

young reindeer, traversed from side to side by a flint with sharpened edge, which is still fixed in the wound it had made in the bone.

Who would, for an instant, refuse to recognize in this the action of the hand of man?

M. Peters has besides discovered in the specimens which MM. Lartet and Christy had forwarded to the museum at Vienna a human incisor.

It results, then, from the whole of these observations that a race of men ignorant of the use of metals lived in Périgord upon the animals procured in the chase and upon fish at a time when the reindeer, the aurochs, and other animals also existed; that they had not tamed any species of animal, not even the dog, and that they made use of the skins of animals sewn together as garments.

This is proved by the discovery of needles made of bone, and of the incisions recognized upon the bone of the leg of the reindeer, from which the people had taken the tendons in order to employ them as thongs, just as the Esquimaux now use them to stitch their dresses.

M. Lartet, whose acquirements in palæontology are at the same time extended and accurate, has studied much more thoroughly than those who have preceded him, the diluvium and the deposits of the quaternary caverns, and has determined the existence of four periods, marked out by the presence of the aurochs, the reindeer, the cave-bear, and the elephant (E. primigenius). The predominance of the bones of the reindeer in the centre of France, would prove that man has lived in Périgord during one of these periods, but would not weaken this truth, admitted as indubitable by the eminent geologist, that is, that man has been coexistent with other huge quaternary mammalia.

Nevertheless, M. Élie de Beaumont, in referring to one of the very numerous communications on the subject of the caverns which

are constantly addressed to the Academy, has protested against this conclusion. For, says he, the more convincing the demonstration of the existence of the reindeer becomes, precisely in the same degree is the insufficiency declared of the supposed proofs of the long-past coexistence of man and the elephant (E. primigenius).

The learned and well-known French geologist cannot admit this contemporary existence, despite the facts and the proofs which seem to be accumulating both in number and weight. M. de Vibray, whose opinion is above suspicion, since, as he says himself, he had at first been a sceptic, has also just brought forward some proofs, having felt himself obliged to yield to the evidence adduced. M. de Lastic has discovered in the grotto of Bruniquel (Aveyrou) a prodigious quantity of bones of the reindeer, of the horse, &c., mingled with human bones, and with objects carved in the form of arrows.

MM. Garrigou, Martin, and Trutat, after examining the débris of the human jawbones found at Bruniquel, have believed themselves warranted in coming to some general conclusion; and in saying that the three jawbones (human) found in the quaternary deposits are to be referred to the brachycephalic type, although they have been met with in different localities by the side of the cavern-bear in the cave of Aurignac, now rendered famous by the tombs and the traces of funeral festivals described by M. Lartet; by the side of the elephant at Moulin-Quignon, and along with the reindeer at Bruniquel. Man then having lived at different dates with animals of various species, appears not the less to have retained his brachycephalic type.

In the grotto of Lourdes, already explored by MM. Lartet and Milne-Edwards, below the layers in which these gentlemen had determined the proofs of the coexistence of man (stone age) and of the reindeer; there should be found, according to a recent communication from MM. Garrigou and Martin, still deeper deposits in which the coexistence of man and of the aurochs would be obvious. In a similar grotto we can then meet with the traces of two distinct ages superposed, one above the other.

MM. Garrigou and Martin have such confidence in the succession of these ages, that in reference to the cavern of the valley of Espalungue, they put forward this positive opinion, that in order to find in this locality the traces of the coexistence of man, of the cavern-bear, and of the elephant (E. primigenius), the search should be made above the cavern, if it is to be attended with any chance of success.

This question of the antiquity of man, only recently so much controverted, is making, as it will be seen, great and rapid progress. We have not mentioned all the labours undertaken, and all the communications made in France, but we may well judge from those which have been referred to, that French geologists have fully appreciated the task which they had to fulfil, and they are giving themselves with a praiseworthy ardour to the study of the soil of their country, so rich in matters relating to races now extinct.

We could not close our notice without acknowledging the readiness MM. Lartet and Christy have shown to communicate their discoveries in the Périgord to the scientific world. After having placed specimens of the highest value from their excavations in the museum of Périgueux, in that of Paris, and having reserved one specially important example for the museum which is being prepared in the Château de St. Germain to receive the beautiful collections presented by M. Boucher de Perthes, and which will be exclusively set apart for illustrations of the history of the antiquity of man;

these gentlemen have forwarded to a large number of the museums of the most important towns of France and of Europe specimens from the excavation of Eyzies.

Whilst he was proprietor of most of the caves which have been explored, Mr. Christy has made the special reservation, that only the *unique* specimens should remain in the country in which they had been found. Is not this disinterestedness above all praise, and does it not prove how thoroughly that antagonism, which petulant minds too often try to foster, between the two first nations of the world, becomes obliterated between men who love science thoroughly and sincerely?

Paris. TH. LACAZE DUTHIERS.

Improved Machinery for Boring Rocks. By George Low.

The last number of the 'Journal of Science' contained a brief reference to my patent boring-machine, in which it was stated that it does not differ materially from others.

In this, your "Chronicler" is under a misapprehension, and I trust I may be permitted to say that my patent machine has many important advantages over those of other makers.

In order to make good this statement, or rather to enable my professional brethren to judge for themselves in the matter, and also because I think that the subject must be one of interest to all classes of readers, I forward to you the following account, illustrated with representations of my boring-machine, and request the favour of its insertion in the Journal.

The cylinder and boring tool of my machine are arranged on a telescopic principle, being only 4 feet 6 inches in length, from end to end, and sufficiently short to swing round in any direction in a tunnel. They are so arranged that they can be set to work in any part of the face, perpendicularly, horizontally, sideways, or at any angle and in any direction, as best suited to the strata, and to meet the convenience of blasting.

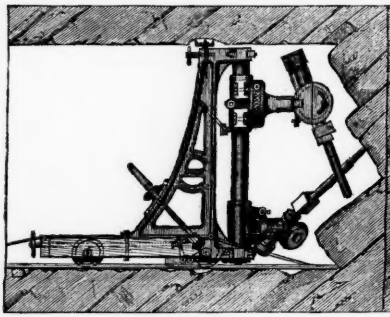


FIG. 1.

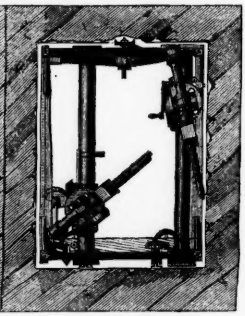


FIG. 2.

In Figures 1 and 2, for instance, which represent a machine adapted for tunnelling, adits, &c., the cylinder is provided with five different movements, and is mounted on a jib, which allows the cylinder and boring tool to be set at any angle, perpendicularly to horizontally; the jib being moved up or down the columns on a screw inside, and the columns can be moved from side to side. The jib is also capable of

being swung round the columns, and with the cylinder it can swing round sideways at any angle in front of the columns. Each of these movements is effected by a hand-wheel, and each set of gear is provided with a tightening break, so as to render the whole perfectly steady whilst in operation. The working parts are covered to protect them from the rock-dust and débris.

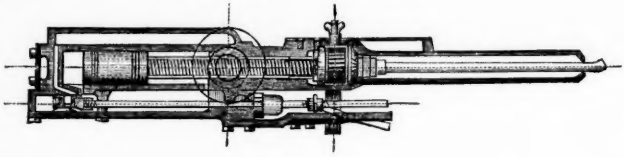


FIG. 3.

Figure 3 shows the cylinder and boring-machine and tool in detail. The chief peculiarities of these are, the shortness of the whole, the fixed cylinder, with telescopic tool, central screw, and parts completely covered. The screw which propels the tool in progress of boring (actuated by a diagonal slot attached to the cylinder by a roller-ratchet wheel) goes up inside the piston-rod, receiving the percussion blows centrally, and thus obviating any danger of the tool leaning to either side.

It will be observed that the cylinder is, as remarked, stationary, the tool and screw being propelled from it in course of boring, instead of a motion being imparted to the cylinder itself. This arrangement allows of *all* the working parts of the cylinder and boring motion being completely covered from rock-dust, wet, &c., which have been found so destructive to boring-machines.

The tool is arranged so that it travels (self-acting) at any rate that may be requisite, proportioned to the hardness of the rock, this being regulated by the position of the

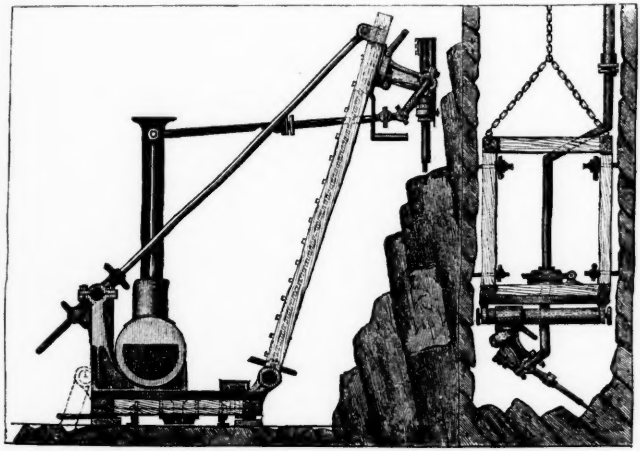


FIG. 4. FIG. 5.

propelling slot. The latter may be placed with a greater or less slope, so as to actuate either one, two, three, or four teeth in the ratchet-wheel, and thus to move the screw more or less quickly.

Figure 4 represents a machine intended for quarries of every description, and Figure 5 is for sinking perpendicular shafts.

With regard to the whole machine, I may add that the carriage frame is provided with a propelling gear, to draw it to or from the face of the rock to be acted on at intervals required for blasting. The various moving gears are so arranged that one man can draw and adjust the borers to work in the necessary direction in a few moments; and the machine may be worked either by compressed air, steam, or water, the first-named being preferable in tunnels, as the escape air provides ventilation. In case steam is used for quarries and perpendicular shafts, it is provided with a condensing apparatus, and the condensed water is injected into the holes at every stroke, whereby these are kept clean. The machines are constructed with carriage frames of different forms, so as to adapt them for driving incline levels, adits, tunnels, perpendicular, slope-face, and flat surface of quarries, open cuttings, &c.; and, according to recent trials, we have been enabled to bore holes with them in hard rocks at the rate of two to four inches per minute.

I trust this brief account may be deemed interesting to your readers.

GEORGE LOW.

Newark-on-Trent,
June, 1864.

Books received for Review.

From *Mr. John Murray*:—

METALLURGY: the Art of Extracting Metals from their Ores, and adapting them to various Purposes of Manufacture. By John Percy, M.D., F.R.S. Vol. II., 'Iron and Steel.'

From *Messrs. Longman & Co.*:—

SAXBY'S WEATHER SYSTEM; or, Lunar Influence on Weather. By S. M. Saxby, R.N., Principal Instructor of Naval Engineers, H.M. Steam Reserve, &c., &c. 2nd edition. Post 8vo, cloth.

THE DOLOMITE MOUNTAINS: Excursions through Tyrol, Carinthia, Carniola, and Friuli. By J. Gilbert and G. C. Churchill, F.G.S. Square crown 8vo, with Illustrations.

OUTLINES OF ASTRONOMY. By Sir J. F. W. Herschel, Bart. 7th edition. 750 pp., illustrated.

THE ABBEVILLE JAW; an Episode in a Great Controversy: being a Paper read before the Hull Literary and Philosophical Society. By J. L. Rome, F.G.S. 84 pp.

THE LAWS OF THOUGHT, OBJECTIVE AND SUBJECTIVE. By Alexander Robertson. 110 pp. 8vo.

From *Mr. Van Voorst*:—

EVENING THOUGHTS. By a Physician. 3rd edition. Post 8vo.

AN ELEMENTARY TEXTBOOK OF THE MICROSCOPE; including a Description of the Methods of Preparing and Mounting Objects, &c. By J. W. Griffith, M.D., F.L.S., &c. 12 coloured plates. Post 8vo.

From *Messrs. J. Churchill & Sons*:—

LECTURES ON THE ELEMENTS OF COMPARATIVE ANATOMY; ON THE CLASSIFICATION OF ANIMALS; AND ON THE VERTEBRATE SKULL. By Thomas Henry Huxley, F.R.S., Professor of Natural History, Royal School of Mines, and Professor of Comparative Anatomy and Physiology to the Royal College of Surgeons of England.

From *Mr. Lovell Reeve*:—

A FLORA OF ULSTER, AND BOTANIST'S GUIDE TO THE NORTH OF IRELAND. By G. Dickie, A.M., M.D., F.L.S., Professor of Botany in the University of Aberdeen. (Joint publishers: Aitchison, Belfast.)

From *Messrs. Simpkin, Marshall, & Co.*:—

GEOLOGICAL ESSAYS AND SKETCH OF THE GEOLOGY OF MANCHESTER AND THE NEIGHBOURHOOD. By John Taylor, author of 'Coal Measures of Great Britain,' &c. (Joint publishers: Ireland & Co., Manchester.)

From *Messrs. Trübner & Co.*:—

FORCE AND MATTER. Empirico-philosophical Studies intelligibly rendered; with an Introduction written expressly for this edition by Dr. Louis Büchner, President of the Medical Association of Hessen-Darmstadt, &c. Edited from the last edition of 'Kraft und Stoff,' by J. Frederick Collingwood, F.R.S.L., F.G.S. Post 8vo.

From *Mr. Stanford*:—

THE PHYSICAL GEOLOGY AND GEOGRAPHY OF GREAT BRITAIN. Six Lectures to Working Men delivered in the Royal School of Mines in 1863. By A. C. Ramsay, F.R.S. 2nd edition. 200 pp. Post 8vo.

From *the Authors*:—

The Utilization of Minute Life: being Practical Studies on Insects, Crustacea, Mollusca, Worms, Polypes, Infusoria, and Sponges. By Dr. T. L. Phipson, F.C.S., &c. (London: Groombridge.)

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